

# MILITARY SPECIFICATION

CAPACITORS, FIXED, PLASTIC (OR PAPER-PLASTIC) DIELECTRIC,  
(HERMETICALLY SEALED IN METAL, CERAMIC, OR GLASS CASES),  
ESTABLISHED AND NON-ESTABLISHED RELIABILITY,  
GENERAL SPECIFICATION FOR

FAILURE RATE LEVEL 'L' IS INACTIVE FOR  
NEW DESIGN AFTER 14 September 1983

This specification is approved for use by all Depart-  
ments and Agencies of the Department of Defense.

## 1. SCOPE

1.1 Scope. This specification covers the general requirements for established reliability (ER) and non-established reliability (non-ER), direct current (dc), plastic or paper-plastic dielectric, fixed capacitors, hermetically sealed in metal or ceramic or glass cases. Capacitors meeting the established reliability requirements specified herein have failure rate (FR) levels ranging from 2.0 percent to 0.001 percent per 1,000 hours (see 1.2.1.9). These FR levels are established at a 90-percent confidence level and maintained at a 10-percent producer's risk and are based on life tests performed at maximum rated voltage and maximum rated temperature. An acceleration factor of 5:1 has been used to related the life test data obtained at 140 percent of rated dc voltage at the applicable high test temperature to the rated voltage at the applicable high test temperature. This specification also covers removable mounting retainers for use with applicable capacitors (see 3.1).

## 1.2 Classification.

1.2.1 Part number. The part number shall be in the following form, and as specified (see 3.1 and 6.2):

CQR09	A	1	M	C	152	K	1	1
ER	Terminal	Circuit	Charac-	Voltage	Capacitance	Capacitance	Vibration	Failure
style	1.2.1.2	1.2.1.3	teristic	1.2.1.5	1.2.1.6	tolerance	grade	rate
1.2.1.1			1.2.1.4			1.2.1.7	1.2.1.8	level
								1.2.1.9

CQ09	A	1	M	C	152	K	1
Non-ER	Terminal	Circuit	Charac-	Voltage	Capacitance	Capacitance	Vibration
style	1.2.1.2	1.2.1.3	teristic	1.2.1.5	1.2.1.6	tolerance	grade
1.2.1.1			1.2.1.4			1.2.1.7	1.2.1.8

Beneficial comments (recommendation, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Electronic Support Division AFLC 2750 ABW/ES, Gentile Air Force Station, Dayton, Ohio 45444 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

1.2.1.1 Style. The style is identified by either the three-letter symbol "CQR" or the two-letter symbol "CQ" followed by a two-digit number. The letters identify plastic (or paper-plastic) dielectric, fixed capacitor, hermetically sealed in metal, ceramic or glass cases. The symbol "CQR" identifies established reliability (ER) capacitors; the symbol "CQ" identifies capacitors for which no specific reliability requirements are specified (non-ER). The first digit following the letter symbols identifies the general shape of the case, and the second digit identifies specific details other than case size. Each style designation may include a family of case sizes.

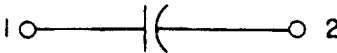
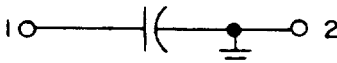
1.2.1.2 Terminal. The terminal is identified by a single letter in accordance with table I.

TABLE I. Terminal.

Symbol	Type of terminal
A - - - -	Axial wire lead.
B - - - -	Solder lug (nonremovable).
C - - - -	Threaded stud and nuts.
D and H - -	Pillar insulator for use at altitudes up to 7,500 feet (22.8 inches of mercury).
E - - - -	Pillar insulator for use at altitudes up to 50,000 feet (3.4 inches of mercury).
F - - - -	Radial wire lead.
G - - - -	Radial pin (a pair of very short rigid terminal leads intended for printed circuit board application).

1.2.1.3 Circuit. The circuit diagram and the number of terminals are identified by a single digit in accordance with table II.

TABLE II. Circuit diagram and number of terminals.

Symbol	Circuit diagram	Number of terminals
1		2
3		2

1.2.1.4 Characteristic. The characteristic is identified by a single letter in accordance with table III.

TABLE III. Characteristic.

	Values of characteristics							
	E	F and G	K <sup>2/</sup>	L	M	P	Q	T
High ambient test temperature, degrees centigrade $\pm 3^\circ\text{C}$ . <sup>1/</sup> - - - - -	85	85	125	65	86	65	125	170
Low ambient test temperature, degrees centigrade $+0^\circ\text{C}$ , $-5^\circ\text{C}$ - - - - -	-65	-55	-65	-30	-65	-65	-55	-65
Life-test dc voltage, in percent of the dc voltage rating (see 4.7.22):								
Watt-second group (see 6.5.3):								
I (0.5 watt-second and less) - - -	140	140	140	---	140	140	150	140
II (0.5+ to 5 watt-seconds) - - -	140	130	140 <sup>3/</sup>	---	---	---	---	---
III (5+ to 50 watt-seconds) - - -	140	110	140	100	---	---	---	---
IV (greater than 50 watt-seconds) -	140	90	140	100	---	---	---	---
Flashpoint of impregnant or filling compound, degrees centigrade - - - - -	142	135	142	176	142	142	142	217

<sup>1/</sup> For characteristic K, voltage derating may be necessary at the high ambient test temperature (see 3.1).

<sup>2/</sup> For tubular units of characteristic K rated at 1,000 volts dc, life test voltage shall be 1,200 volts.

<sup>3/</sup> For tubular units of characteristic K in watt-seconds group II, use 130 percent of the dc voltage rating at  $40^\circ\text{C}$  for life-test dc voltage.

1.2.1.5 Voltage. The dc voltage rating for continuous operation at the high ambient test temperature specified in table III (except for characteristic K which is for  $85^\circ\text{C}$  operation), is identified by a single letter in accordance with table IV.

TABLE IV. DC voltage rating. <sup>1/</sup>

Symbol	DC voltage rating <sup>1/</sup>
	<u>Volts</u>
Z - - - -	30
A - - - -	50
B - - - -	100
C - - - -	200
D - - - -	300
E - - - -	400
F - - - -	600
G - - - -	1,000
H - - - -	1,500
J - - - -	2,000
K - - - -	2,500
L - - - -	3,000
M - - - -	4,000
N - - - -	5,000
P - - - -	6,000
R - - - -	7,500
S - - - -	10,000
T - - - -	12,500
U - - - -	25,000

<sup>1/</sup> For characteristic K, voltage derating may be necessary at the high ambient test temperature (see 3.1).

1.2.1.6 Capacitance. The nominal capacitance value expressed in picofarads (pF) is identified by a three-digit number; the first two digits represent significant figures, and the last digit specifies the number of zeros to follow.

1.2.1.7 Capacitance tolerance. The capacitance tolerance in percent is identified by a single letter in accordance with table V.

TABLE V. Capacitance tolerance.

Symbol	Capacitance tolerance
	<u>Percent (±)</u>
F - - - - -	1
G - - - - -	2
J - - - - -	5
K - - - - -	10

1.2.1.8 Vibration grade. The vibration grade is identified by a single digit in accordance with table VI.

TABLE VI. Vibration grade.

Symbol	Frequency range	Acceleration
	<u>Hz</u>	<u>G</u>
1 - - - - -	10 to 55 inclusive	---
3 - - - - -	10 to 2,000 inclusive	15

1.2.1.9 Failure rate level. The failure level in percent per 1,000 hours is identified by a single letter in accordance with table VII, and is based on rated voltage at the high test temperature, as applicable.

TABLE VII. Failure rate level.

Symbol	Failure rate level (percent per 1,000 hours)
L - - - - -	2.0
M - - - - -	1.0
P - - - - -	0.1
R - - - - -	0.01
S - - - - -	0.001

## 2. APPLICABLE DOCUMENTS

### 2.1 Government documents.

2.1.1 Specifications and standards. The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

#### SPECIFICATION

##### MILITARY

- MIL-I-10 - Insulating Compound, Electrical, Ceramic, Class L.
- MIL-C-39028 - Capacitors, Packaging of.

(See Supplement 1 for list of associated specification sheets.)

## STANDARDS

### NATIONAL BUREAU OF STANDARDS

FED-STD-H28 - Screw-Thread Standards for Federal Services.

(Application for copies should be addressed to the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402.)

### MILITARY

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.  
 MIL-STD-202 - Test Methods for Electronic and Electrical Component Parts.  
 MIL-STD-690 - Failure Rate Sampling Plans and Procedures.  
 MIL-STD-790 - Reliability Assurance Program for Electronic Parts Specifications.  
 MIL-STD-810 - Environmental Test Methods and Engineering Guidelines.  
 MIL-STD-1285 - Marking of Electrical and Electronic Parts.

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

### AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

D92-57 - Method of Test for Flash and Fire Points by Cleveland Open Cup.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA. 19103.)

## 3. REQUIREMENTS

3.1 Specification sheets. The individual item requirements shall be as specified herein and in accordance with the applicable specification sheets. In the event of any conflict between requirements for this specification and the specification sheet, the latter shall govern (see 6.2).

3.2 Qualification. Capacitors and retainers furnished under this specification shall be products which are qualified for listing on the applicable qualified products list at the time set for opening of bids (see 4.4 and 6.4). In addition, the manufacturer shall obtain certification from the qualifying activity that the reliability assurance requirements of 4.1.1 have been met and are being maintained for the ER styles. Unless procured from the manufacturer or his authorized distributor listed or approved for listing on the qualified products list. Established Reliability parts furnished under this specification shall not be considered as having met the requirements of this specification.

3.3 Reliability (applicable to ER capacitors only, see 3.1). Reliability of ER capacitors furnished under this specification shall be established and maintained in accordance with the procedures and requirements specified in MIL-STD-790 and MIL-STD-690 with details specified in 4.1.1, 4.4.4, 4.5, and 4.6.1.3.

3.4 Material. The material shall be as specified herein; however, when a definite material is not specified, a material shall be used which will enable the capacitors and retainers to meet the performance requirements of this specification. Acceptance or approval of any constituent material shall not be construed as a guaranty of the acceptance of the finished product.

3.4.1 Impregnant and filling compounds. Compounds used in the impregnation and filling of capacitors shall be chemically inactive with respect to the capacitor element and the case (see 3.5.1). The compound, either in the state of original application or as a result of having aged, shall have no adverse effect on the performance of the capacitor. For liquid-filled capacitors, the same material shall be used for impregnating as is used for filling (see 6.3).

3.4.2 Dielectric material. Dielectric material (see 3.1) utilized in the fabrication of capacitors shall be one of the following materials:

<u>Characteristic</u>	<u>Material</u>
E, F, G, and K - - - - -	Paper and polyethylene terephthalate
L- - - - -	Polypropylene
M- - - - -	Polyethylene terephthalate
P- - - - -	Polystyrene
Q- - - - -	Polycarbonate
T- - - - -	Polytetrafluoroethylene

3.5 Design and construction. Capacitors and retainers shall be of the design, construction, and physical dimensions specified (see 3.1).

3.5.1 Case. Each capacitor shall be enclosed in a hermetically-sealed metal or ceramic or glass case (see 3.1) which will prevent leakage of the impregnant or filling compound and, in addition, will protect the capacitor element from moisture and mechanical damage under all test conditions specified herein. Ceramic used for case materials shall conform to MIL-I-10. The use of exterior cardboard sleeves for insulating purposes shall not be permitted.

3.5.2 Noninductive construction. Unless otherwise specified (see 3.1), tubular capacitors shall be of extended-foil construction. When tab construction is used, each pair of tabs shall be brought from opposite foils within one turn of the foil winding from each other, unless otherwise specified (see 3.1).

### 3.5.3 Terminals.

3.5.3.1 Case as terminal. When the case is used as a terminal, any protective coating applied to the mounting surfaces shall be such as to provide a direct conducting path for an electric current from the case to the surface on which it is mounted.

3.5.3.2 Solder lugs and solder-lug terminals. Solder lugs and solder lug-terminals may be of any shape, provided dimensional limits are met, and shall be coated with solder having a tin content of 40 to 70 percent.

3.5.3.3 Screw terminals. Screw terminals shall be supplied with one nut, one flat washer, and one lockwasher.

3.5.3.4 Wire leads and pins. Leads and pins shall be of copper or copper covered steel. Copper covered steel leads and pins shall have a minimum of 30 percent of the conductivity of electrolytic copper. Leads and pins shall be coated with solder having a tin content of 40 to 70 percent.

3.5.3.5 Terminal insulators. Terminal insulators shall be glass or ceramic.

3.5.4 Threaded parts. All threaded parts shall be as specified (see 3.1), and in accordance with FED-STD-H28.

3.5.4.1 Engagement of threaded parts. All threaded parts shall engage by at least three full threads.

3.5.4.2 Locking of screw-thread assemblies. All screw-thread assemblies shall be rendered resistant to loosening under vibration. Lockwashers shall be provided under all nuts.

3.6 Burn-in (ERs only, when applicable, see 3.1). When capacitors are tested as specified in 4.7.3, there shall be no evidence of damage, arcing or breakdown.

3.7 Radiographic inspection (ERs only, when applicable, see 3.1). When capacitors are tested as specified in 4.7.4, X-ray examination shall disclose no evidence of improperly made connections, misalignments of seals or eyelets, substandard soldering or structural weakness, or solder particles or slivers attached to one end.

3.8 Thermal shock. When tested as specified in 4.7.5, capacitors and retainers shall withstand the extremes of high and low temperatures without visible damage.

3.9 Seal. When capacitors are tested as specified in 4.7.6, there shall be no continuous visible stream of bubbles or other evidence of leakage.

3.10 Dielectric withstanding voltage (DWV).

3.10.1 Capacitors. When capacitors are tested as specified in 4.7.7.1, there shall be no momentary or intermittent arcing or other indication of breakdown, nor shall there be any visible evidence of damage.

3.10.2 Sleeving (when applicable, see 3.1). When capacitors are tested as specified in 4.7.7.2, the insulating sleeve shall withstand the specified potential without breakdown.

3.11 Barometric pressure (reduced) (when applicable, see 3.1). When capacitors are tested as specified in 4.7.8, there shall be no momentary or intermittent arcing or other indication of breakdown, nor shall there be any visible evidence of damage.

3.12 Insulation resistance (IR).

3.12.1 Sleeving (when applicable, see 3.1). When measured as specified in 4.7.9, the insulation resistance shall be not less than 1,000 megohms.

3.12.2 Terminal to terminal. When measured as specified in 4.7.9, the insulation resistance shall be not less than the applicable values specified (see 3.1).

3.12.3 Terminal to case. When measured as specified in 4.7.9, the insulation resistance between any terminal and case, when the case is not a terminal, shall exceed 50,000 megohms, unless otherwise specified (see 3.1).

3.13 Capacitance. When measured as specified in 4.7.10, the capacitance shall be within the tolerance specified (see 3.1).

3.14 Dissipation factor. When measured as specified in 4.7.11, the dissipation factor shall not exceed the applicable value specified (see 3.1).

3.15 Vibration. When capacitors are tested as specified in 4.7.12, there shall be no intermittent contacts of 0.5 milliseconds (ms) or greater duration or momentary arcing, or other indication of breakdown, nor shall there be any open-or-short circuiting or evidence of mechanical damage. In addition, retainers, as tested to 4.7.12 shall exhibit no evidence of mechanical damage.

3.16 Salt spray (corrosion) (metal surfaces only, see 3.1). When capacitors or retainers are tested as specified in 4.7.13, there shall be no evidence of harmful corrosion, and at least 90 percent of any exposed metal surfaces of the capacitor or retainer shall be protected by the finish. For capacitors or retainers with painted surfaces, not more than 10 percent of the surfaces shall be affected by flaking, peeling, or blistering of paint. There shall be no evidence of unwrapping of or mechanical damage to insulating sleeves. In addition, corrosion of the terminal hardware or mounting surface shall not exceed 10 percent of the surface area. Marking shall remain legible.

NOTE: Harmful corrosion shall be construed as any type of corrosion which in any way interferes with the mechanical or electrical performance of the capacitor or retainer, as applicable.

3.17 Immersion. When tested as specified in 4.7.14, capacitors or retainers, as applicable, shall meet the following requirements:

a. Capacitors:

Dielectric withstanding voltage:

Insulating sleeves (when applicable, see 3.1)- - Not less than 4,000 V dc.

Terminal to terminal - - - - - As specified in 3.10.1.

Terminal to case - - - - - As specified in 3.10.1.

Insulation resistance at 25°C:

Insulating sleeves (when applicable, see 3.1)- - Not less than 1,000 megohms.

Terminal to terminal - - - - - Not less than 1,000 megohms. Unless otherwise specified, not less than 60 percent of the value specified in 3.12.2.



Terminal to case - - - - -	Unless otherwise specified, not less than 50 percent of the value specified in 3.12.3.
Capacitance- - - - -	Shall change not more than $\pm 1.0$ percent from the value obtained when measured as specified in 4.7.10.
Dissipation factor - - - - -	Shall not exceed 120 percent of the initial value specified (see 3.1).

## b. Capacitors and retainers:

Visual examination - - - - -	There shall be no harmful or extensive corrosion of the capacitors or retainers. The marking shall remain legible.
------------------------------	--

3.18 Solderability (wire leads only, see 3.1). When capacitors are tested as specified in 4.7.15, the dipped portion of the terminals shall conform to the solid-wire termination criteria of method 208 of MIL-STD-202.

3.19 Shock (specified pulse). When capacitors are tested as specified in 4.7.16, there shall be no intermittent contacts of 0.5 ms or greater duration, or arcing or other indications of breakdown, nor shall there be any open or short circuiting or evidence of mechanical damage.

3.20 Terminal strength. When capacitors are tested as specified in 4.7.17, there shall be no mechanical damage to the capacitor or terminals.

3.21 Moisture resistance. When tested as specified in 4.7.18, capacitors or retainers, applicable, shall meet the following requirements:

## a. Capacitors:

## Dielectric withstanding voltage:

Insulating sleeves (when applicable, see 3.1)- - - Not less than 4,000 V dc.

Terminal to terminal - - - - - As specified in 3.10.1

Terminals to case (circuit diagram 1 only) - - - As specified in 3.10.1

## Insulation resistance at 25°C:

Insulating sleeves (when applicable, see 3.1)- - - Not less than 1,000 megohms.

Terminal to terminal - - - - - Not less than 60 percent of the value specified in 3.12.2.

Terminals to case (circuit diagram 1 only) - - - Not less than 50 percent of the value specified in 3.12.3.

Capacitance- - - - - Shall change not more than  $\pm 0.5$  percent ( $\pm 2.0$  percent for characteristic M) from the value obtained when measured as specified in 4.7.10.

Dissipation factor - - - - - Shall not exceed 120 percent of the initial values specified (see 3.1).

## b. Capacitors and retainers:

Visual examination - - - - -	There shall be no harmful or extensive corrosion of the capacitors or retainers. The marking shall remain legible.
------------------------------	--

3.22 Dielectric absorption (when specified, see 3.1). When measured as specified in 4.7.19, the dielectric absorption shall not exceed the value specified (see 3.1).

3.23 Stability at low and high temperatures. When capacitors are tested as specified in 4.7.20, there shall be no indication of breakdown or arcing, nor shall there be any open- or short-circuiting or any visible evidence of mechanical damage. The capacitance changes at the specified temperatures shall not exceed the applicable limits specified (see 3.1) from value at 25°C.

3.24 Temperature coefficient (characteristic P only, see 3.1). When measured as specified in 4.7.21, the temperature coefficient shall not exceed  $-120 \pm 50$  parts per million per degree Celsius (ppm/°C).

3.25 Life. When tested as specified in 4.7.22, capacitors shall meet the following requirements:



Insulation resistance at 25°C - - - - -	Unless otherwise specified, not less than 60 percent of the value specified in 3.12.1.
Capacitance - - - - -	Shall change not more than the percent specified (see 3.1) of the initial value obtained when measured as specified in 4.7.10.
Dissipation factor- - - - -	Unless otherwise specified, shall not exceed the initial value specified (see 3.1).
Visual examination - - - - -	There shall be no leakage of impregnant or filling compound or deformation of the case either during or after the test.

3.26 Fungus. The manufacturer shall certify that all external materials are fungus resistant or shall perform the test specified in 4.7.23. When capacitors are tested as specified in 4.7.23, examination shall disclose no evidence of fungus growth on the external surface.

3.27 Resistance to solvents. When capacitors are tested as specified in 4.7.24, there shall be no evidence of mechanical damage and the marking shall remain legible.

3.28 Resistance to soldering heat (applicable to wire-lead capacitors only). When tested as specified in 4.7.25, capacitors shall meet the following requirements:

Insulation resistance at 25°C - - - - -	As specified in 3.12.
Capacitance - - - - -	Change not more than 5 percent from the initial value obtained when measured as specified in 4.7.10.
Dissipation factor- - - - -	Shall not exceed initial limit.

3.29 Flashpoint of impregnant or filling compound. When measured as specified in 4.7.26, the flashpoint of impregnant or filling compound shall be equal to or greater than 142°C unless otherwise specified (see 3.1).

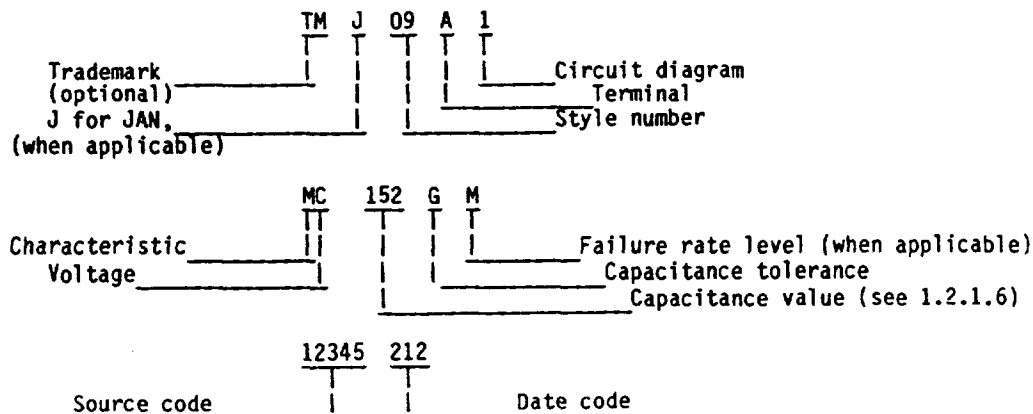
### 3.30 Marking.

3.30.1 Capacitors. Marking of capacitors shall conform to method I of MIL-STD-1285 and shall include the part number, "JAN" brand, trademark (optional), source code, date code, lot symbol, and when space permits, capacitance (in  $\mu\text{F}$ ), capacitance tolerance, and rated voltage, and when applicable, failure rate level. Unless otherwise specified (see 3.1), capacitors shall be marked as shown in the following example:

#### EXAMPLE:

CQR09A1MC152K1M	- Part number.
JAN TM 12345	- "JAN" brand (ER styles only), trademark (optional) and source code.
8520A.0011 $\mu\text{F}$	- Date code, lot symbol and capacitance.
10% 1000 VDC	- Capacitance tolerance and rated voltage.

3.30.2 Partial marking. For tubular capacitors with case sizes of .175 by .406, .195 by .406 and .235 by .406, the following partial marking may be used.



3.30.3 Retainer. Retainers shall be marked with the part number, trademark (optional), and source code. Marking shall be on the outer surface of the retainers.

3.30.4 JAN and J marking (ER styles only). The United States Government has adopted, and is exercising legitimate control over, the certification marks "JAN" and "J", respectively, to indicate electrical equipment, namely resistors, capacitors, electron tubes and the like, procured by, or manufactured for use by, or for the Government in accordance with standard Government specifications. Accordingly, capacitors procured to, and meeting all of, the criteria specified herein and in applicable specification sheets shall bear the certification mark "JAN", except that capacitors too small to bear the certification mark "JAN" shall bear the letter "J". Capacitors furnished under contracts or orders which either permit or require deviation from the conditions or requirements specified herein and in applicable specification sheets shall not bear "JAN" or "J". In the event a capacitor sample fails to meet the requirements of this specification and the applicable specification sheets, the manufacturer shall remove the "JAN" or the "J" from the sample tested and also from all capacitors represented by the sample. The United States Government has obtained Certificate of Registration No. 504,860 for the certification mark "JAN".

3.30.5 Remarking when supplying to higher FR levels. A manufacturer supplying to higher FR levels as provided by MIL-STD-690 shall not remark the parts unless specified in the contract or purchase order (see 6.2).

3.30.6 Non-ER marking. An ER part may be marked and furnished as a non-ER part if produced on the same assembly line, and provided it is subject to and meets all the inspection requirements of the ER part.

3.31. Workmanship. Capacitors and retainers shall be processed in such a manner as to be uniform in quality and shall be free from pits, corrosion, cracks, rough edges, and other defects that will affect life, serviceability, or appearance.

#### 3.31.1 Soldering.

3.31.1.1 Flux. Flux for soldering of electrical connections shall be rosin, rosin and alcohol, or rosin and turpentine. No acid or acid salts shall be used in preparation for or during soldering; however, exception is permitted for preliminary tinning of electrical connections and for tinning or soldering of mechanical points not used to complete electrical circuits, but in no case shall acid salts be used where they can come in contact with insulating material. Where acid or acid salts are used as permitted herein, they shall be completely neutralized and removed immediately after use. All excess flux and solder shall be removed. Where possible, electrical connections shall be mechanically secure before soldering and electrically continuous after soldering.

3.31.1.2 Process. There shall be no sharp points or rough surfaces resulting from insufficient heating. The minimum necessary amount of flux and solder shall be used for electrical connections. Any means employed to remove an unavoidable excess of flux shall not incur the risk of loose particles of flux, brush bristles, or other foreign material remaining in or on the capacitor; flux being spread over a large area; or damage to the capacitor. Insulation material that has been subjected to heating during the soldering operation shall be undamaged and parts fastened thereto shall not have become loosened.

3.31.2 Riveting (retainers only). The riveting operation shall be performed carefully to insure that the rivet is tight and satisfactorily headed.

### 4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Reliability assurance program (applicable to ER parts only). A reliability assurance program shall be established and maintained in accordance with MIL-STD-790 with the following exceptions:

- a. Only the following of paragraph 5.2.7 (j) shall apply: 'the manufacturer shall, as a minimum, be able to identify the time period during which the final production operation was performed on each item of product prior to final test. The date or lot code marked on each part shall be identified to a production lot.'
- b. Paragraph 5.2.11.3 shall not apply.

4.2 Classification of inspection. The inspections specified herein are classified as follows:

- a. Qualification inspection (see 4.4).
- b. Retention of qualification (non-ER styles only) (see 4.5) or verification of qualification (ER styles only) (see 4.5.1).
- c. Quality conformance inspection (see 4.6).

4.3 Inspection conditions. Unless otherwise specified herein, all inspections shall be performed in accordance with the test conditions specified in the "GENERAL REQUIREMENTS" of MIL-STD-202.

4.4 Qualification inspection 1/. Qualification inspection shall be performed at a laboratory acceptable to the Government (see 6.4) on sample units produced with equipment and procedures normally used in production.

4.4.1 Sample size. The number of capacitors or retainers to be submitted for qualification inspection shall be as specified in table VIII or IX, respectively, or the appendix to this specification.

4.4.2 Inspection routine.

4.4.2.1 Capacitor submission. Capacitors shall be subjected to the qualification inspection specified in table VIII in the order shown. All sample units shall be divided as specified in table VIII for groups I through VIII inclusive, and subjected to the inspection for their particular group; for combined voltage group submissions, each type shall be equally represented in each group.

4.4.2.2 Retainer submission. Fourteen sample retainers shall be subjected to the examination and tests specified in table IX in the order shown or the appendix to this specification. Two specimens of each type represented in a sample shall be subjected to group I tests. Retainers shall then be subjected to the tests of group II. During these tests, one set of each retainer type shall support a capacitor of the same case designation with which it is normally used (see 3.1). Tests on retainers may be run concurrently with those specified for capacitors in 4.4.2.1. Each retainer shall be considered as a specimen for the purpose of determining defectives.

4.4.3 Failures. Failures in excess of those allowed in table VIII or IX, as applicable, shall be cause for refusal to grant qualification approval.

4.4.4 Failure rate (FR) qualification (applicable to ER parts only). FR qualification for capacitors shall be in accordance with the general and detailed requirements of MIL-STD-690 and the following details:

- a. Procedure I - Qualification at the initial FR level. Level "M" (1.0 percent), of FRSP-90 shall apply. Sample units shall be subjected to the qualification inspection specified in group V, table VIII (see 4.4.2.1). The entire life test sample shall be continued on test to 6,000 hours as specified in 4.7.22.3, upon completion of the 2,000 hour qualification.
- b. Procedure II - Extension of qualification to lower FR levels. To extend qualification to the "R" (0.01 percent), and "S" (0.001 percent) FR levels, data from two or more styles of similar construction may be combined.
- c. Procedure III - Maintenance of FR level qualification. Maintenance period B of FRSP-10 shall apply. Regardless of the number of production lots produced during this period, the specified number of unit hours shall be accumulated to maintain qualification (see 4.6.1).

1/ Qualification approval will be based on the successful completion of the tests specified in table VIII, and will not be withheld pending completion of the extended-life test of 4.4.4(a).

TABLE VIII. Qualification inspection for capacitors.

Inspection	Requirement paragraph	Method paragraph	NON-ER		ER	
			Number of sample units to be inspected	Number of defectives allowed <u>1</u> /	Number of sample units to be inspected	Number of defectives allowed <u>1</u> /
<u>Group I</u>						
Visual and mechanical examination (internal):	---	4.7.2	2	0	2	0
Material, design, construction, and workmanship - - - - -	3.1, 3.4, 3.5, and 3.31					
<u>Group II</u>						
Visual and mechanical examination (external):	---	4.7.2	43	1	80	0
Physical dimensions, marking, and workmanship <u>2</u> / - - - - -	3.1, 3.5, and 3.31.2 incl.					
Burn-in (ER only, when applicable) <u>3</u> / - - - - -	3.6.1	4.7.3				
Radiographic inspection (ER only, when applicable) <u>3</u> / - - - - -	3.7	4.7.4				
Thermal shock <u>3</u> / - - - - -	3.8	4.7.5				
Seal - - - - -	3.9	4.7.6				
Dielectric withstanding voltage <u>3</u> /	3.10	4.7.7				
Barometric pressure (reduced) (when applicable) <u>3</u> / - - - - -	3.11	4.7.8				
Insulation resistance <u>3</u> / - - - - -	3.12	4.7.9				
Capacitance <u>3</u> / - - - - -	3.13	4.7.10				
Dissipation Factor <u>3</u> / - - - - -	3.14	4.7.11				
<u>Group III</u>						
Vibration - - - - -	3.15	4.7.12	6	1	12	1
Salt spray (corrosion) (metal case only) - - - - -	3.16	4.7.13				
Immersion - - - - -	3.17	4.7.14				
<u>Group IV</u>						
Solderability (wire leads only) -	3.18	4.7.15	6	1	6	1
<u>Group V</u>						
Shock (specified pulse) - - - - -	3.19	4.7.16	6	1	12	1
Terminal strength - - - - -	3.20	4.7.17				
Moisture resistance - - - - -	3.21	4.7.18				
<u>Group VI</u>						
Dielectric absorption (when specified) - - - - -	3.22	4.7.19	24	1	40	1
Stability at low and high temperatures <u>3</u> / - - - - -	3.23	4.7.20				
Temperature coefficient (characteristic P) - - - - -	3.24	4.7.21				
Life - - - - -	3.25	4.7.22				

See footnotes at end of table.

TABLE VIII. Qualification inspection for capacitors - Continued.

Inspection	Requirement paragraph	Method paragraph	NON-ER		ER	
			Number of sample units to be inspected	Number of defectives allowed <u>1</u> /	Number of sample units to be inspected	Number of defectives allowed <u>1</u> /
<u>Group VII</u>						
Fungus- - - - -	3.26	4.7.23	} N/A	} ---	} 5 5 } 10	} 1
Resistance to solvents- - - - -	3.27	4.7.24				
Resistance to soldering heat (wire lead only)- - - - -	3.28	4.7.25				
<u>Group VIII</u>						
Flashpoint of impregnant or filling compound- - - - -	3.29	4.7.26	2 <u>4</u> /	---	2 <u>4</u> /	---

1/ A sample unit having one or more defects will be considered as a single defective.

2/ Marking defects are based on visual examination only and will be charged only for illegible, incomplete, or incorrect marking.

3/ Nondestructive tests.

4/ Two samples shall be taken from the .25-pound impregnant or filling compound submitted.

TABLE IX. Qualification inspection for retainers.

Inspection	Requirement paragraph	Method paragraph	Number of specimens to be inspected	Number defectives allowed 1/
<b>Group I</b>				
Visual and mechanical examination	3.1, 3.5 to 3.5.4.2 as applicable and 3.30 to 3.31.2 incl.	4.7.2	2	0
<b>Group II</b>				
Vibration 2/	3.15	4.7.12	12	1
Salt spray (corrosion)	3.16	4.7.13		
Thermal shock	3.8	4.7.5		

1/ A specimen having one or more defects shall be considered as a single defective.

2/ During vibration tests, one set of each retainer type shall support a capacitor or a dummy of comparable weight and size.

4.5 Retention of qualification (non-ER styles only). To retain qualification, the supplier shall forward a report at 6-month intervals to the qualifying activity. The qualifying activity shall establish the initial reporting date. The report shall consist of:

- a. A summary of the results of the tests performed for inspection of product for delivery (groups A and B), indicating as a minimum the number of lots that have passed and the number that have failed. The results of tests of all reworked lots shall be identified and accounted for.
- b. A summary of the results of tests performed for periodic inspection (group C), including the number and mode of failures. The summary shall include results of all periodic inspection tests performed and completed during the 6-month period. If the summary of the test results indicates nonconformance with specification requirements, and corrective action acceptable to the qualifying activity has not been taken, action may be taken to remove the failing product from the qualified products list.

Failure to submit the report within 30 days after the end of each 6 month period may result in loss of qualification for the product. In addition to the periodic submission of inspection data, the supplier shall immediately notify the qualifying activity at any time during the 6 month period that the inspection data indicates failure of the qualified product to meet the requirements of the specification.

In the event that no production occurred during the reporting period, a report shall be submitted certifying that the company still has the capabilities and facilities necessary to produce the item. If during 3 consecutive reporting periods there has been no production, the manufacturer may be required, at the discretion of the qualifying activity, to submit a representative product of each style to testing in accordance with the qualification inspection requirements.

**4.5.1 Verification of qualification (ER styles only).** Every 6 months the manufacturer shall compile a summary of the results of quality conformance inspections and extended FR test data, in the form of a verification of qualification report, and forward it to the qualifying activity within 30 days after the end of the reporting period as the basis of continued qualification approval. In addition, the manufacturer shall immediately notify the qualifying activity whenever the FR data indicates that the manufacturer has failed to maintain the qualified FR level, or the group C inspection data indicates failure of the qualified product to meet the requirements of this specification. Continuation shall be based on evidence that over the 6-month period the following has been met:

- a. Verification by the qualifying activity that the manufacturer meets the requirements of MIL-STD-790.
- b. The manufacturer has not modified the design of the item.
- c. The specification requirements for the item have not been amended so far as to affect the character of the item.
- d. Lot rejection for group A inspection does not exceed 5 percent or one lot, whichever is greater.
- e. The requirements for group C inspection are met.
- f. The records of all FR test combined substantiate that the "M" or "P" FR level has been maintained or that the manufacturer continues to meet the "R" or "S" FR level for which qualified, although the total component hours of testing may not, as yet, meet the requirements of 4.4.4c.

When Group C requirements were not met and the manufacturer has taken corrective action satisfactory to the Government, group C retesting shall be instituted. A summary of the retesting shall be forwarded to the qualifying activity within 30 days after completion of the retest.

#### **4.6 Quality conformance inspection.**

**4.6.1 Inspection of product for delivery.** Inspection of product for delivery shall consist of groups A and B inspections. Group B, subgroup 2 need not be completed before shipment on lots of less than 50 pieces.

**4.6.1.1 Inspection lot.** An inspection lot shall consist of all capacitors in one or more styles, produced under essentially the same conditions, and offered for inspection in one month. The sample selected from the lot shall be representative of the styles in the lot. ER parts shall be kept separate from non-ER parts. Styles may be grouped by characteristic as follows:

<u>Group</u>	<u>Characteristic</u>	
1 - - -	K	CQR09, CQR12, CQR13, CQR19, CQR39, CRQ42, and CQR43.
2 - - -	M	CQR29, CAR32, and CQR33.
3 - - -	Q	CQR07.
4 - - -	E, F, G, or K	CQ72.
5 - - -		All non-ER styles may be grouped by characteristic.

**4.6.1.2 Group A inspection.** Group A inspection shall consist of the examination and tests specified in table X, and shall be made on the same set of sample units in the order shown.



4.6.1.2.1 Sampling plan. Subgroup 1 tests, except as indicated in table X and subgroup 2 tests, shall be performed on each ER capacitor offered for acceptance. Such tests shall not be repeated for purposes of reinspection. Statistical sampling and inspection for subgroups 1, 2, and 3 for non-ER capacitors, and subgroup 3 for ER capacitors shall be in accordance with MIL-STD-105 for general inspection level II. The acceptable quality level (AQL) and limiting quality (LQ) shall be as specified in table X. At the option of the manufacturer, numerically lower AQL levels may be used as long as the specified LQ is not exceeded numerically.

4.6.1.2.2 Manufacturer's production inspection (for ER parts only). If the manufacturer performs test equal to or more stringent than those specified in subgroup 1, table X, as the final step of his production process, group A, subgroup 1 inspection may be waived and the data resulting from the manufacturer's production tests may be used instead. Authority to waive the subgroup 1 inspection shall be granted by the qualifying activity only. The following criteria shall be complied with:

- a. Tests conducted by the manufacturer during production shall be clearly identical to or more stringent than that specified for subgroup 1. Test conditions shall be equal to or more stringent than those specified for subgroup 1.
- b. Manufacturer subjects 100 percent of the product supplied under this specification to his production tests.
- c. The parameters measured and the failure criteria shall be the same as, or more stringent than, those specified herein.
- d. The lot rejection criteria is the same as, or more stringent than, those specified herein.
- e. The manufacturer shall make available all information concerning the test procedures and instrumentation used in his production tests. This data shall be provided as part of the evaluation required for MIL-STD-790. The manufacturer shall also make available to the Government all records of all detail test data resulting from production tests.
- f. Once approved, the manufacturer shall not change the test procedure or criteria without prior notification and concurrence by the qualifying activity.

TABLE X. Group A inspection.

Inspection	Requirement paragraph	Method paragraph	NON-ER		ER Quality level (% defective)	
			AQL (% defective)			
			Major	Minor		
<u>Subgroup 1</u>						
Burn in 1/ - - - - -	3.6	4.7.3	Not applicable		100% inspection	
Radiographic inspection 1/ - - - -	3.7	4.7.4				
Thermal shock- - - - -	3.8	4.7.5	.65	---		
Seal - - - - -	3.9	4.7.6				
Dielectric withstanding voltage (capacitor only) - - - - -	3.10.1	4.7.7.1				
<u>Subgroup 2</u>						
Insulation resistance (at 25°C)- -	3.12	4.7.9	.65	---		
Capacitance- - - - -	3.13	4.7.10				
Dissipation factor - - - - -	3.14	4.7.11				
<u>Subgroup 3</u>						
Visual and mechanical examination (external):			.65	2.5	1.0 (AQL) 7.6 (LQ)	
Physical dimensions- - - - -	3.1,3.5	4.7.2				
Marking- - - - -	3.30	4.7.2				
Workmanship- - - - -	3.31	4.7.2				

1/ For all ER styles.



4.6.1.2.3 Rejected lots. Lots rejected by the group A inspection shall be segregated from new lots and those lots that have passed inspection. Lots rejected because of failures in subgroup 2 may be offered for acceptance only if the manufacturer inspects all units in the lot for those quality characteristics found defective in the sample, and after removing all defective units found, reinspects the lot using the tightened inspection procedure of MIL-STD-105. Resubmitted lots shall be kept separate from new lots, and shall be clearly identified resubmitted lots. If, during the 100-percent inspection of subgroups 1 and 2 (ER parts only), screening requires that over 5 percent of the capacitors be discarded, the lot shall be rejected.

4.6.1.2.4 Disposition of sample units. Sample units which have passed all the group A inspection may be delivered on the contract or order, if the lot is accepted.

#### 4.6.1.3 Group B inspection.

4.6.1.3.1 For ERs and non-ERs. Group B inspection shall consist of the test specified in subgroups 1 and 2 of table XI, in the order shown, and shall be performed on sample units which have been subjected to and have passed the applicable tests of group A inspection.

4.6.1.3.1.1 Sampling plan. The sampling plan for subgroups 1 and 2, as applicable, shall be in accordance with MIL-STD-105 for special inspection level S-4. (The sample size selected for these tests shall be based on the lot size.) The AQL and LQ shall be as specified in table XI. At the option of the manufacturer, a numerically lower AQL may be used as long as the LQ is not exceeded numerically.

TABLE XI. Group B inspection.

Inspection	Requirement paragraph	Method paragraph	Quality levels (percent defective) sample selection	
			NON-ER	ER
<u>Subgroup 1</u>				
Insulation resistance (at high ambient test temperature) - - -	3.12	4.7.9	2.5 (AQL)	2.5 (AQL) 13 (LQ)
Dielectric absorption (when specified)- - - - -	3.22	4.7.19		
Stability at low and high temperatures- - - - -	3.23	4.7.20		
Temperature coefficient (characteristic P only) - - - -	3.24	4.7.21		
Barometric pressure (reduced) - -	3.11	4.7.8		
			Number of sample units to be inspected	
			FR level <u>1/</u>	
			L	M, P, R, & S
<u>Subgroup 2</u>				
Life (240 hour) - - - - -	3.25	4.7.22.2.1	2.5 (AQL)	21 (minimum) 10

1/ For all ER styles.

4.6.1.3.2 For FR level L. Group B inspection shall consist of the tests specified in table XI and shall be performed on sample units which have been subjected to and have passed group A inspection. The lot conformance FR procedures are as specified in procedure IV of MIL-STD-690 with the following details and exceptions:

- Lot sampling - 21 sample units (minimum).
- Duration of lot conformance FR test - 240 hours.
- Failure criteria - See 3.25, one failure allowed.

d. Permissible combinations - See 4.6.1.1.

e. Disposition of samples and inspection lot - Samples may be delivered on contract or order provided they are 100-percent inspected to verify that they meet all requirements listed in table XI, subgroup 2. However, a minimum of 10 sample units shall be randomly selected from the sample units and subjected to the extended life test as specified in 4.6.1.3.4. The inspection lot may be shipped upon successful completion of lot conformance FR test.

4.6.1.3.3 For FR levels M, P, R, and S. A minimum of 10 sample units shall be selected at random from each inspection lot and shall be inspected as specified in 4.6.2.1.1.2. Units selected may be subjected to specified test before 1 month has elapsed.

4.6.1.3.4 Extended life test (for FR level L) (not applicable for styles CQR39, CQR42, and CQR43). Sample units which have been selected for extended life test (see 4.6.1.3.2) shall be subjected to an additional 5,760 hours of life test as specified in 4.7.22.3.2.

4.6.1.3.5 Reject lots. If an inspection lot is rejected as a result of failure to pass group B inspection, the lot shall not be resubmitted. However, if the lot is rejected because of failure to pass the stability at low and high temperature test of subgroup 1, the lot may be resubmitted provided the defective units are removed and the lot is then subjected to 100-percent inspection for those characteristics found defective. Resubmitted lots shall be kept separate from new lots, and shall be clearly identified as resubmitted lots. Even though the lot has been rejected, those units which were predesignated for extended life testing shall remain or be placed on test for the full length of time.

4.6.2 Periodic inspection. Periodic inspection shall consist of group C inspection. Except where the results of these inspections show noncompliance with the applicable requirement (see 4.6.2.1.4), delivery of products which have passed groups A and B inspections shall not be delayed pending results of periodic inspection.

4.6.2.1 Group C inspection. Group C inspection shall be performed on sample units which have been subjected to and have passed the applicable tests (by FR level and non-ER styles) for group A inspection and shall consist of the test specified in table XII in the order shown. Test data shall be reviewed as part of the complete verification of qualification.

#### 4.6.2.1.1 Sampling plan.

4.6.2.1.1.1 For all non-ER styles and FR levels. Sample units shall be selected from the first lot and thence from every 2 months production for subgroups 1, 2, 3, and 4, and every 12 months for subgroup 5. The highest watt-second rating in each style, characteristic, and voltage manufactured during the specified periods shall be represented in at least the approximate ratio of production. A different sample shall be selected for each subgroup.

4.6.2.1.1.2 For FR levels M, P, R, and S. In addition to the tests specified in 4.6.2.1.1.1, a minimum of 10 sample units from each inspection lot (see 4.6.1.1) shall be subjected to subgroup 4 of table XII (see 4.6.1.3.3). Allowable failures shall be as specified in table IV, maintenance period A of MIL-STD-690.

4.6.2.1.2 Failures. If the number of failures exceeds the number allowed in table XII, the sample shall be considered to have failed.

4.6.2.1.3 Disposition of sample units. Sample units which have been subjected to group C inspection shall not be delivered on the contract or order.

4.6.2.1.4 Noncompliance (applicable to both ER and non-ER parts). If a sample fails to pass group C inspection, the manufacturer shall take corrective action on the materials or processes, or both, as warranted, and on all units of product which can be corrected and which were manufactured under essentially the same conditions, with essentially the same materials, processes, etc., and which are considered subject to the same failure. Acceptance of the product shall be discontinued until corrective action, acceptable to the Government, has been taken. After the corrective action has been taken, group C inspection shall be repeated on additional sample units (all inspection, or the inspection which the original sample failed, at the option of the Government). Groups A and B inspections may be reinstituted; however, final acceptance shall be withheld until the group C reinspection has shown that the corrective action was successful. In the event of failure after reinspection, information concerning the failure and corrective action taken shall be furnished to the qualifying activity and the contracting officer or purchaser.

TABLE XII. Group C inspection.

Inspection	Requirement paragraph	Method paragraph	Number of sample units to be inspected	Number of defectives allowed	
				NON-ER	ER
<u>Subgroup 1</u>					
Shock (specified pulse) (not applicable to ceramic- or-glass-cased units) - - - - -	3.19	4.7.16	12	1	1
Vibration- - - - -	3.15	4.7.12			
Salt spray (corrosion) (metal cases only) - - - - -	3.16	4.7.13			
Immersion- - - - -	3.17	4.7.14			
<u>Subgroup 2</u>					
Solderability (wire lead styles only)- - - - -	3.18	4.7.15	6	1	1
<u>Subgroup 3</u>					
Terminal strength- - - - -	3.20	4.7.17	12	1	1
Moisture resistance- - - - -	3.21	4.7.18			
Dielectric withstanding voltage (sleeving only)- - - - -	3.10.2	4.7.7.2			
<u>Subgroup 4</u>					
Life - - - - -	3.25	4.7.22.2.2	12(non-ER) ER (see 4.6.2.1.1)	1	See 4.6.2.1.1
<u>Subgroup 5 (every 6 months)</u>					
Resistance to solvents - - - - -	3.27	4.7.24	6	N/A	1
Resistance to soldering heat (wire-lead styles only)- - - - -	3.28	4.7.25			

4.6.3 Inspection of packaging. The sampling and inspection of the preservation, packing, and container marking shall be in accordance with the requirements of MIL-C-39028.

#### 4.7 Methods of examination and test.

##### 4.7.1 Measurement conditions.

4.7.1.1 AC measurements. Alternating-current (ac) measurements shall be made at the frequency specified. The magnitude of the ac voltage shall be limited to 1.0 volt root-mean-square (rms). The maximum dc bias voltage shall be 2.2 volts-for all ac measurements of capacitors.

4.7.1.2 Reference measurements. When requirements are based on comparative measurements made before and after conditioning, the reference measurement shall be considered the last measurement made at 25°C ±5°C prior to conditioning. Unless reference measurements have been made within 30 days prior to the beginning of conditioning, they shall be repeated.

4.7.1.3 Power supply. The power supply used for life testing shall have a regulation of ±2 percent or less of the rated voltage. The power source employed for dc leakage current measurements shall be stabilized to at least ±100 parts per million. No voltage fluctuations shall occur during measurements that would produce a variation in the current measurement as read with any acceptable dc leakage current tester used to test capacitors.

4.7.2 Visual and mechanical examination. Capacitors and retainers shall be examined to verify that the material, design, construction, physical dimensions, marking, and workmanship are in accordance with the applicable requirements. (See 3.1, 3.4, to 3.5.3 inclusive, and 3.30 to 3.31.1.2 inclusive.)

4.7.3 Burn-in (see 3.6) (ERs only, when applicable, see 3.1). Capacitors shall be subjected to 140 percent of the dc rated voltage at the high ambient test temperature for 48 +8, -0 hours. During this test, capacitors shall be adequately protected against temporary voltage surges of 10 percent or more of the test voltage. After the test, capacitors shall show no evidence of damage, arcing, or breakdown.

4.7.4 Radiographic inspection (X-ray) (see 3.7) (ERs only, when applicable, see 3.1). Capacitors shall be tested in accordance with method 209 of MIL-STD-202. The following details shall apply:

- a. Radiographic quality - Sufficient definition to determine that specimens are free from defects specified in 3.7.
- b. Image-quality indicator - As sample part of the same type as the part being radiographed that contains either an actual or simulated defect which is at least 10 percent smaller than the smallest defect to be detected.
- c. Positions of specimen - Two views perpendicular to the terminal axis. After first view, specimen shall be rotated 90 degrees for the second view.
- d. Evaluation of images:
  - (1) Special kind of viewing equipment - Magnifying glass.
  - (2) Magnification - 10X.
  - (3) Defects to be sought in specimen - As specified in 3.7.

4.7.5 Thermal shock (see 3.8). Capacitors and retainers shall be tested in accordance with method 107 of MIL-STD-202. The following details and exceptions shall apply:

- a. Test condition letter - Unless otherwise specified, B, except that during step 3, capacitors shall be conditioned at the high ambient test temperature (see 3.1).
- b. Measurements before and after cycling - Not applicable.

4.7.6 Seal (see 3.9). Capacitors shall be tested in accordance with method 112, MIL-STD-202. The following details shall apply:

- a. Test condition letter - As specified, see 3.1.
- b. Examination after test - Capacitors shall be visually examined for evidence of leakage.

4.7.6.1 Seal (alternative test (see 3.9)). For capacitors with a liquid impregnant, the following seal test may be substituted: Capacitors shall be placed on a clean sheet of absorbent paper and exposed to the applicable high ambient test temperature for a minimum of 1 hour. The capacitor shall then be visually examined for evidence of leakage of impregnant or filling compounds or bubbles from the seal. Capacitors to be subjected to the salt spray (corrosion), and immersion tests may be excluded from the seal test until after the salt spray (corrosion), and immersion tests are completed.

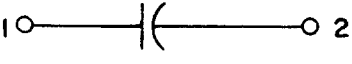
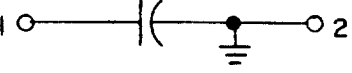
4.7.7. Dielectric withstanding voltage (see 3.10).

4.7.7.1 Capacitors. Capacitors shall be tested in accordance with method 301, MIL-STD-202. The following details and exceptions shall apply:

- a. Magnitude of test voltage - As specified in table XIII.
- b. Nature of potential - dc.
- c. Duration of application of test voltage - As specified in table XIII.
- d. Points of application of test voltage - As specified in table XIII.
- e. Examinations after test - Capacitors shall be visually examined for evidence of breakdown, arcing, or other visible damage.

4.7.7.2 Sleeving (see 3.10.2) (when applicable, see 3.1). With the capacitor horizontally mounted, a single loop of No. 20 AWG wire shall be secured around the insulating sleeve of the capacitor so that it extends downward from the capacitor 3 inches minimum, and the two ends of the wire twisted in about three cross turns. A 1-pound minimum weight shall then be suspended from the looped wire. After exposure in this position for a minimum of 24 hours, at the maximum rated temperature  $\pm 3^\circ\text{C}$ , a dc voltage of 4,000 volts minimum, shall be applied between the case and the looped wire. The rate of voltage application shall be 500 volts per second and the duration of application of test voltage shall be 15 seconds, minimum.

TABLE XIII. Dielectric-withstanding-voltage test details.

Circuit-diagram symbol	Circuit diagram	Test points	Test connections	Magnitude of test voltage	Duration of application of voltage
				Percent rated dc voltage	Minutes
1		Terminal to terminal Terminal to case <u>3/</u>	1 to 2 1 and 2 to case	200 <u>1/</u> 200	1 <u>2/</u> 1
3		Terminal to terminal	1 to 2 or 1 to case	200 <u>1/</u>	1 <u>2/</u>

1/ 175 percent rated dc voltage after immersion, and moisture resistance tests.

2/ For the 100-percent inspection specified in 4.6.1.2, the capacitors shall be subjected, at the option of the manufacturer, to the application of 250 percent of rated dc voltage for not less than 5 seconds, or 200 percent for not less than 15 seconds.

3/ For quality conformance inspection, application of potential may be made between each terminal individually and the case.

4.7.8 Barometric pressure (reduced) (see 3.11) (when applicable, see 3.1). Capacitors shall be tested in accordance with method 105 of MIL-STD-202. The following details and exceptions shall apply:

- a. Method of mounting - By normal mounting means.
- b. Test condition - Unless otherwise specified (see 3.1), capacitors shall be subjected to a pressure of 0.82 inch of mercury (80,000 feet).
- c. Test during subjection to reduced pressure - Unless otherwise specified (see 3.1), a potential equal to that specified in table XIV, as applicable, shall be applied for at least 1 minute between test points specified (see 3.1). A suitable means shall be used to detect momentary or permanent breakdown. Capacitors shall then be visually examined for evidence of damage. (See 6.5.5).

TABLE XIV. Barometric-pressure test potentials.

Case diameter	DC voltage (max) <u>1/</u>
<u>Inch</u>	<u>Volts</u>
0.175 - - - - -	200
0.195 - - - - -	200
0.235 - - - - -	300
0.312 - - - - -	430
0.400 - - - - -	500
0.562 and up- - - - -	640

1/ The dc voltage shall be limited to 200 percent of the dc voltage rating at maximum rated temperature.

4.7.9 Insulation resistance (see 3.12). Capacitors shall be tested in accordance with method 302, MIL-STD-202. The following details and exceptions shall apply:

a. Test potential:

- (1) Insulating sleeves - When applicable (see 3.1) - Test condition B.
- (2) Terminal to terminal and terminal to case - A potential equal to the rated dc voltage (see 3.1) or 500 V dc, whichever is less.

b. Special conditions - The time constant of the measurement circuit with the capacitor connected shall not exceed 30 seconds.

c. Points of measurement:

- (1) Insulating sleeves - The test potential shall be applied between the case and a piece of metal foil placed around the insulating sleeve; the metal foil shall be of such dimension as to allow at least .125-inch surface exposure of the insulating sleeve on each end (see 3.12.1).
- (2) Terminal to terminal - Insulation resistance shall be measured between terminals at the maximum rated temperature,  $\pm 3^{\circ}\text{C}$ , and at  $25^{\circ}\text{C} \pm 3^{\circ}\text{C}$  (see 3.12.2).
- (3) Terminals to case - When the case is not a terminal, the measurement shall be made between each terminal and the case at  $25^{\circ}\text{C} \pm 3^{\circ}\text{C}$  (see 3.12.3).

d. Electrification time - 2 minutes.

4.7.10 Capacitance (see 3.13.). Capacitors shall be tested in accordance with method 305 of MIL-STD-202. The following details shall apply:

- a. Test frequency - 1,000  $\pm 100$  Hertz (Hz) for capacitors whose nominal capacitance does not exceed 1  $\mu\text{F}$  and whose dc voltage rating does not exceed 3,000 volts. For capacitors not within these limits, measurements shall be made at a frequency of 100  $\pm 6$  Hz or corrected thereto.
- b. Limit of accuracy - Shall be within  $\pm 0.1$  percent.

4.7.11 Dissipation factor (see 3.14). The dissipation factor shall be measured with an ac voltage not greater than 20 percent of the dc voltage rating, at a frequency of 1,000  $\pm 100$  Hz, for capacitors whose nominal capacitance does not exceed 1  $\mu\text{F}$  and whose dc voltage rating does not exceed 3,000 volts. For capacitors not within these limits, measurements shall be made at a frequency of 100  $\pm 6$  Hz or corrected thereto. Measurement accuracy shall be one of the following:

- a. For dial reading -  $\pm 2$  percent of dial reading or, .001, whichever is greater.
- b. For digital readout -  $\pm 0.001$  percent  $\pm 2$  percent of reading.



4.7.12 Vibration (see 3.15 and 3.1).

4.7.12.1 Low frequency. Capacitors shall be tested in accordance with method 201 of MIL-STD-202. The following details and exceptions shall apply:

- a. Tests and measurements prior to vibration - Not applicable.
- b. Method of mounting - Securely fastened by normal mounting means, except that capacitors without mounting retainers in sizes 1.562 inch long or 0.670 inch in diameter or larger shall be mounted by a supplemental means other than the wire leads. Wire-lead capacitors shall be secured .5  $\pm$ .125 inch from the case. The extraneous leads beyond the .5 inch securing point may be removed or supplemental support may be added.
- c. Duration of vibration:  
For tublar styles - 4 hours (2 hours in each of 2 mutually perpendicular planes).  
For rectangular styles - 6 hours (2 hours in each of 3 mutually perpendicular planes).
- d. Test and measurements during vibration - During the last 30 minutes of vibration in each direction, a signal of 1  $\pm$ 0.2 kilohertz (kHz) at a level of 1  $\pm$ 0.5 volts shall be placed across the capacitor and measured with suitable ac detecting equipment to determine open - or short-circuits, or intermittent contacts. The accuracy of the detecting equipment shall be sufficient to detect any interruption with a duration of 0.5 ms or greater.
- e. Examination after vibration - Capacitors shall be visually examined for evidence of mechanical damage.

4.7.12.2 High frequency. Capacitors and retainers shall be tested in accordance with method 204 of MIL-STD-202. The following details and exceptions shall apply:

- a. Mounting of specimens - Capacitors shall be rigidly mounted by the body to a vibration test apparatus. Wire-lead capacitors shall be secured .5  $\pm$ .125 from the case. The extraneous leads beyond the .5 inch securing point may be removed or supplemental support may be added.
- b. Electrical-load conditions - During the test, a potential of 125 percent of the dc rated voltage shall be applied between the terminals of the capacitor.
- c. Test condition letter - B, with exception as specified (see 3.1).
- d. Measurements - During the last cycle in each direction, a signal of 1  $\pm$ 0.2 kHz at a level of 1  $\pm$ .05 volts shall be placed across the capacitor and measured with a suitable ac recording device ( a permanent record is not necessary for this test) to determine open- or short-circuits, or intermittent contacts. The accuracy of the detecting equipment shall be sufficient to detect any interruption with a duration of 0.5 ms or greater.
- e. Measurements and examination after vibration - After the test, with capacitors still mounted on the vibration jig, the insulating sleeve shall be tested for dielectric withstanding voltage, as specified in 4.7.7, with a potential of 2,000 V dc between the case and bracket. Capacitors and retainers shall be visually examined for evidence of mechanical damage.

4.7.13 Salt spray (corrosion) (see 3.16). Capacitors and retainers shall be tested in accordance with method 101, MIL-STD-202. The following details and exceptions shall apply:

- a. Applicable salt solution - The salt solution concentration shall be 5 percent.
- b. Test condition letter - B (48 hours).
- c. Examination after exposure - Capacitors and retainers shall be visually examined for evidence of harmful corrosion, unwrapping of or mechanical damage to insulating sleeves (when applicable), and obliteration of marking.



4.7.14 Immersion (see 3.17). Capacitors and retainers shall be tested in accordance with method 104 of MIL-STD-202. The following details shall apply:

- a. Test condition letter B.
- b. Measurements after final cycle - For capacitors with insulating sleeves, dielectric withstanding voltage, and insulation resistance at 25°C shall be measured as specified in 4.7.7 and 4.7.9, respectively. The test potential shall be applied between the case and a piece of metal foil placed around the insulating sleeve; the metal foil shall be of such dimension as to allow at least .125-inch surface exposure of the insulating sleeve on each end. In addition, dielectric withstanding voltage and insulation resistance at 25°C of all capacitors shall be measured as specified in 4.7.7 and 4.7.9, respectively. Capacitors and retainers shall then be examined for harmful or extensive corrosion and obliteration of marking.

4.7.15 Solderability (wire leads only, see 3.1) (see 3.18). Capacitors shall be tested in accordance with method 208 of MIL-STD-202. The following details shall apply:

- a. Number of terminations to be tested - Both leads of the capacitor shall be subjected to the solderability test.
- b. Depth of immersion in flux and solder - The leads shall be immersed to within .125 inch of the capacitor body.

4.7.16 Shock (specified pulse) (see 3.19). Capacitors and retainers shall be tested in accordance with method 213 of MIL-STD-202. The following details shall apply:

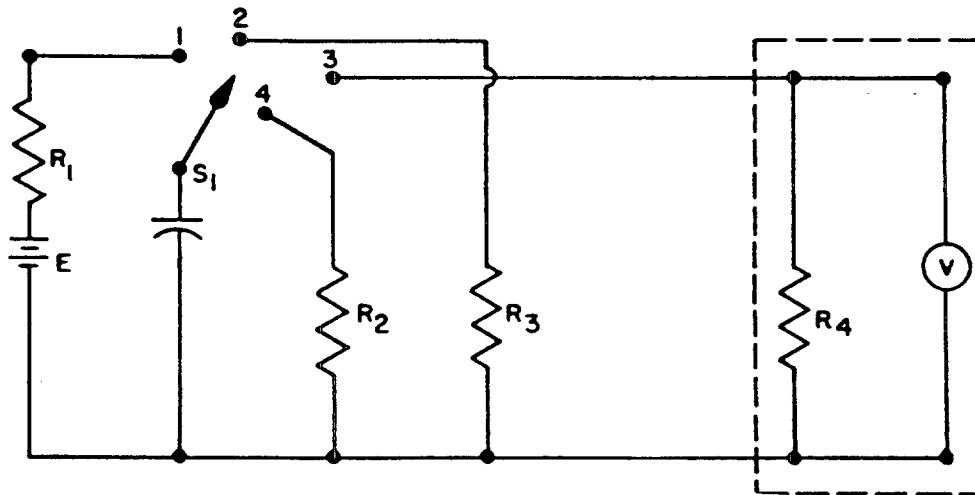
- a. Mounting - The body of the capacitor shall be securely fastened by mounting retainers. The leads shall be soldered to rigidly supported terminals so spaced that the length of each lead from the capacitor shall be .5 ±1/8 inch from the edge of the supporting terminal.
- b. Test condition letter - I (100 G's).
- c. Electrical loading during shock - During the test, a potential of 125 percent of the dc voltage rating shall be applied between the terminals of the capacitor.
- d. Measurements during shock - During the test, observations shall be made to determine intermittent contact or arcing or open- or short-circuiting. Detecting equipment shall be sufficiently sensitive to detect any interruption with a duration of 0.5 ms or greater.
- e. Examinations after test - Capacitors shall be visually examined for evidence of breakdown, arcing, fractures, or any other visible mechanical damage. Retainers shall be visually examined for mechanical damage.

4.7.17 Terminal strength (see 3.20). Capacitors shall be tested in accordance with method 211 of MIL-STD-202. The following details and exceptions shall apply:

- a. Test condition letter - As specified (see 3.1).
- b. Examination after test - The capacitors and terminals shall be examined for mechanical damage.

4.7.18 Moisture resistance (see 3.21). Capacitors and retainers shall be tested in accordance with method 102, test condition D, MIL-STD-202, except that no measurement shall be made before and after cycling. Capacitors shall then be tested in accordance with method 106, MIL-STD-202. The following details and exceptions shall apply:

- a. Initial measurements - Not applicable.
- b. Polarization voltage - During steps 1 to 6, inclusive, a dc potential of 100 volts shall be applied across the terminals of 50 percent of the capacitors. No potential shall be applied to the remaining 50 percent of the capacitors.



$E$  = dc rated dc voltage or 100 volts dc, whichever is less ( $\pm 2\%$ ).

$R_1$  and  $R_2$  = 1000 Ohms  $\pm 20\%$ . (This value not critical.)

$R_3$  = 5 Ohms  $\pm 1\%$ .

$R_4$  = 10,000 Megohms - Minimum.

Suggest use of  $\pm 1230A$  GR electrometer or equivalent set to 10,000 Megohms range input resistance.

NOTES:

1. Charge for 5 minutes  $\pm 10$  seconds with switch in position 1.
2. Switch in position 2 for 5 seconds  $\pm 0.5$  seconds.
3. Switch in position 3 for 1 minute.
4. After 1 minute read recovery voltage and compute as a percentage of charge voltage.
5. Switch to position 4, discharge and remove.

FIGURE 1. Typical production dielectric absorption test method.

- c. Loading voltage - Not applicable.
- d. Final measurements - After the final cycle, the capacitors shall be conditioned at 25°C ±5°C and a relative humidity of 50 ±5 percent for a period of at least 22 hours but not more than 24 hours. Dielectric withstanding voltage and insulation resistance at 25°C shall be measured on insulating sleeves as specified in 4.7.7 and 4.7.9, respectively. The test potential shall be applied between the case and a piece of metal foil placed around the insulating sleeve. The metal foil shall be of such dimension as to allow at least .125-inch surface exposure of the insulating sleeve on each end. In addition, dielectric withstanding voltage, insulation resistance, capacitance, and dissipation factor at 25°C, of all capacitors shall be measured as specified in 4.7.7, 4.7.9, 4.7.10, and 4.7.11, respectively.

After the test, capacitors and retainers shall be visually examined for evidence of harmful corrosion and obliteration of marking; capacitors shall be examined for unwrapping of or mechanical damage to insulated sleeves, when applicable.

4.7.19 Dielectric absorption (see 3.22), (when specified, see 3.1). The capacitor shall be charged at the dc voltage rating for 1 hour ±1 minute. The initial surge current shall not exceed 50 milliamperes. At the end of this period, the capacitor shall be disconnected from the power source and discharged through a 5-ohm ±5 percent resistor for 10 ±1 seconds. The discharge resistor shall be disconnected from the capacitor at the end of the 10-second discharge period, and the voltage remaining on the capacitor (recovery voltage) shall be measured with an electrometer or other suitable device having an input resistance of 10,000 megohms or greater. Recovery voltage shall be read at the maximum voltage within a 15-minute period. The dielectric absorption shall be computed from the following formula:

$$d = \frac{V_1}{V_2} \times 100$$

Where:

d = Percent dielectric absorption.  
 $V_1$  = Maximum recovery voltage.  
 $V_2$  = Charging voltage.

For an alternate production test method see figure 1.

4.7.20 Stability at low and high temperatures (see 3.23). Capacitors shall be placed in a chamber maintained at -65°C ±0°C, -5°C or -55°C ±0°C, -5°C (as applicable, see 3.1), and a potential equal to the dc rated voltage shall be applied at this condition for 48 ±4 hours. The air within the conditioning chamber shall be circulated. Before capacitors are moved from the conditioning chamber, capacitance shall be measured at the applicable low temperature (see 3.1) as specified in 4.7.9. Capacitance shall then be measured at the following temperature as specified in 4.7.9 (the measurement at each temperature shall be recorded when two successive readings taken at 5-minute intervals indicate no change in capacitance):

25°C ±5°C  
 High ambient test temperature (see 3.1)  
 25°C ±5°C

After the test, capacitors shall be visually examined for evidence of breakdown, arcing, open- and short-circuiting, and other visible mechanical damage.

4.7.21 Temperature coefficient (see 3.24) (characteristic P only, see 3.1). Capacitance measurements shall be made after the capacitors have been stabilized at each of the following temperatures: -65°C, +25°C, and the high ambient test temperature (see 3.1). Stability shall be indicated when no change exists in two capacitance measurements made at 5-minute intervals. Temperature coefficient shall be computed from the following formula:

$$T_C = \frac{(C_2 - C_1) 10^6}{(T_2 - T_1) C_1}$$

Where:

$T_C$  = temperature coefficient in ppm/°C.  
 $C_1$  = capacitance at 25°C in pF.  
 $C_2$  = capacitance at test temperature in pF.  
 $T_1$  = 25°C.  
 $T_2$  = test temperature in degrees C.

#### 4.7.22 Life (see 3.25).

4.7.22.1 2,000-hour (qualification inspection). Capacitors shall be tested in accordance with method 108 of MIL-STD-202. The following details and exceptions shall apply:

- a. Distance of temperature measurements from specimens, inches - Not applicable.
- b. Test temperature and tolerance - At the applicable high-test temperature, +4°C, -0°C (see 3.1).
- c. Operating conditions - Capacitors shall be subjected to 140 percent of the rated dc voltage. The surge current shall be limited to between 5 milliamperes and 1 ampere. When necessary, a suitable current-limiting resistor shall be used.
- d. Test condition letter - F (see table XV).
- e. Measurements during and after exposure - At the conclusion of the test, the capacitors shall be returned to the inspection conditions specified in 4.3 and shall be visually examined for evidence of mechanical damage and obliteration of marking; insulation resistance at +25°C, capacitance, and dissipation factor shall be measured as specified in 4.7.9, 4.7.10, and 4.7.11, respectively.

TABLE XV. Life test in hours.

NON-ER capacitors				
Characteristic	Qualification	Group B	Group C	
E, F, and G	240 +48, -0	240 +48, -0	---	
K	240 +48, -0 <u>1/</u>	240 +48, -0 <u>1/</u>	---	
M	2,000 +72, -0	240 +48, -0	1,760 +72, -0	
P	240 +48, -0	240 +48, -0	---	
T	240 +48, -0	240 +48, -0	---	
Q	240 +48, -0	240 +48, -0	---	
ER capacitors				
Style	Qualification	Group B	Group C	Extended life
CQR39, 42, and 43	240 +48, -0	---	240 +48, -0	---
FR levels M, P, R, S, for all styles except CQR39, 42, and 43	2,000 +72, -0	---	2,000 +72, -0	4,000 +72, -0
FR level L, for all styles except CQR39, 42, and 43	2,000 +72, -0	240 +48, -0	---	5,760 +72, -0

1/ Test time for characteristic K tubular capacitors with voltage ratings of 1,000 volts shall be 500 ±12 hours.

#### 4.7.22.2 Hours (quality conformance inspection).

4.7.22.2.1 240-hour (group B inspection) (see 3.25). Capacitors shall be tested as specified in 4.7.22.1, except the duration of the test shall be 240 +48, -0 hours.

4.7.22.2.2 2,000-hour (group C inspection) (see 3.25). Except as specified in the following, capacitors shall be tested as specified in 4.7.22.1:

a. Test duration - See table XV.

b. Measurements during and after exposure - Measurements, as specified in 4.7.22.1(e), shall be taken at the following intervals of exposure: During the first hour, 240 +48, -0, 1,000 +48, -0, and 2,000 +72, -0.

#### 4.7.22.3 Extended life (see 3.25).

4.7.22.3.1 Following 2,000-hour qualification inspection. Sample units that have been subjected to 2,000 hours of life test as specified in 4.7.22.1 and 4.7.22.2.2, shall remain on test for an additional 4,000 +72, -0 hours. After completion of the 6,000-hour life test time capacitors shall be measured as specified in 4.7.22.1(e).

4.7.22.3.2 Following 240-hour group B inspection (ER parts only) (see table XV). Sample units that have been subjected to 240 hours of life test as specified in 4.7.22.2.1, shall remain on test for an additional 5,760 hours. Measurement, as specified in 4.7.22.1(e), shall be taken at the following intervals of exposure: After 240 +48, -0, 1,000 +48, -0, 2,000 +72, -0, 4,000 +72, -0, and 6,000 +72, -0 hours.

4.7.22.3.3 Following 240-hour group B inspection (non-ER parts, characteristic M only, see table XV). Every 3 months, 12 sample units that have successfully completed the 240-hour group B life test, shall be continued on test for an additional 1,760 +72, -0 hours.

4.7.23 Fungus (see 3.26). Capacitors shall be tested in accordance with method 508 of MIL-STD-810. Pretest and post-test measurements are not required.

4.7.24 Resistance to solvents (see 3.27) Capacitors shall be tested in accordance with method 215 of MIL-STD-202. The following details shall apply:

- a. Portion of specimen to be brushed - That portion on which marking is present.
- b. Number of specimens to be tested - As specified in applicable inspection tables.
- c. Permissible extent of damage - As specified in 3.27.

4.7.25 Resistance to soldering heat (see 3.28) (applicable to wire-lead capacitors only). Capacitors shall be tested in accordance with method 210 of MIL-STD-202. The following details shall apply:

- a. Depth of immersion in the molten solder - To a minimum of 0.250 inch from the capacitor body.
- b. Test condition letter - B (260°C ±5°C; 10 ±1 seconds).
- c. Cooling time prior to measurement after test - 10 ±1 minutes.

4.7.26 Flashpoint of impregnant or filling compound (see 3.29). The flashpoint of impregnant or filling compound shall be measured as specified in ASTM D92-57, except that the fire point and precision do not apply. "Impregnant or filling compound" shall be substituted for the word "oil" throughout the test method.

## 5. PACKAGING.

5.1 Packaging requirements. The requirements for packaging shall be in accordance with MIL-C-39028.

## 6. NOTES

### 6.1 Intended use.

6.1.1 Polystyrene dielectric capacitors. Capacitors of polystyrene dielectric, because of their low dielectric absorption and radiofrequency losses, are intended primarily for use in calculators, computers, integrators, time-base oscillators, laboratory standards, and other pulse applications. The outstanding characteristics of these capacitors are low temperature coefficient and stability.

6.1.2 Polyethylene terephthalate dielectric capacitors. Capacitors of polyethylene terephthalate dielectric are intended for use in high temperature applications similar to those served by hermetically sealed paper capacitors, but where higher insulation resistance at the upper temperature limits is required.

6.1.3 Paper and polyethylene terephthalate dielectric capacitors. Capacitors of paper and polyethylene terephthalate dielectric are intended for applications where small case sizes and high temperature operation are required.

6.1.4 Polytetrafluoroethylene dielectric capacitors. Capacitors of polytetrafluoroethylene dielectric are intended for high temperature applications where high insulation resistance, small capacitance change, and low dielectric absorption are required. These capacitors exhibit excellent insulation resistance values at high temperatures.

6.1.5 Polycarbonate dielectric capacitors. Capacitors of polycarbonate dielectric are especially suitable for use in tuned circuits and precision timing due to their capacitance stability and minimum capacitance change with temperature.

## 6.2 Ordering data. Procurement documents should specify the following:

- a. Title, number, and date of this specification.
- b. Title, number and date of the applicable specification sheet and the complete part number (see 1.2 and 3.1).
- c. Whether removable mounting retainers are to be supplied with capacitors (see 3.1).
- d. If remarking of parts is required to indicate FR level (see 3.30.5).

## 6.3 Definitions.

6.3.1 Liquid-impregnated capacitor. A liquid-impregnated capacitor is a capacitor in which a liquid impregnant is dominantly contained within the capacitor element, but does not occupy substantially all of the case volume not required by the capacitor element and its connection.

6.3.2 Liquid-filled capacitor. A liquid-filled capacitor is a capacitor in which a liquid impregnant occupies substantially all of the case volume not required by the capacitor element and its connections. Space may be allowed for the expansion of the liquid with temperature variations.

6.3.3 Nonmagnetic case capacitor. A nonmagnetic case capacitor is a capacitor in which no part of the case or retainer is made of magnetizable material; however, the end seal may be made of a material having a ferrous metal content in order to effect a glass-to-metal seal.

6.3.4 Hermetic seal. For the purpose of this specification, a hermetically sealed capacitor is one in which the capacitive element is contained within a sealed enclosure of ceramic, glass or metal, or combinations thereof, where sealing is accomplished by material fusion, welding, brazing or soldering. The capacitor shall be capable of passing the seal test specified in 4.7.6 or of meeting a leak-rate requirement of not more than  $1.76 \times 10^6$  cubic centimeters ( $\text{cm}^3$ ) per second, when determined by any other method having sensitivity equal to or better than the stated limit. When capacitors are tested as specified in 4.7.6, there shall be no continuous visible stream of bubbles.

6.4 Qualification. 2/ With respect to products requiring qualification, awards will be made only for products which are at the time set for opening of bids qualified for inclusion in the applicable qualified products list whether or not such products have actually been so listed by that date. The attention of the suppliers is called to this requirement, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the qualified products list is the Air Force Acquisition Logistics Division, ATTN: PTS Gentile AF Station, OH 45444. However, information pertaining to qualification of products may be obtained from the Defense Electronics Supply Center (DESC-EQ), 1507 Wilmington Pike, Dayton, Ohio 45444.

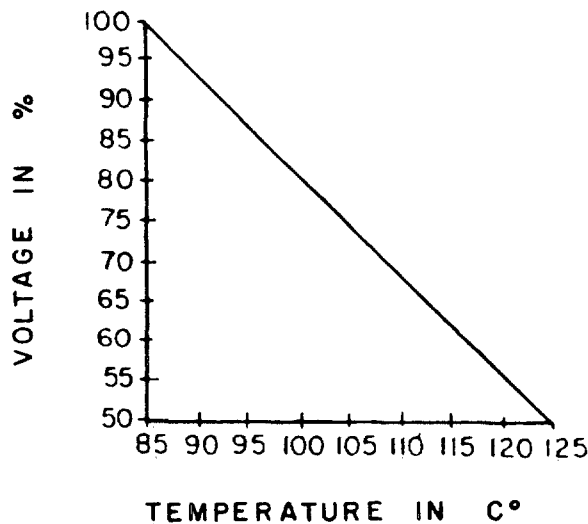
## 6.5 Application information.

6.5.1 Mounting. Capacitors covered by this specification shall be mounted by a retainer or clamp or should be potted when vibration or shock are likely to be encountered in service.

6.5.2 Voltage derating with temperature (for characteristic M). Characteristic M tubular capacitors may be used in applications up to  $125^\circ\text{C}$  with voltage derating as indicated in figure 2. However, insulation resistance requirements at  $125^\circ\text{C}$  cannot be expected to exceed 100 megohm-microfarads; greater capacitance change may be encountered, and life expectancy of the unit will be reduced.

2/ SD-6, "Provisions Governing Qualification," is issued for the information of applicants requesting qualification of product. Copies of this publication may be obtained from the Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.



FIGURE 2. Intended operating temperature.

6.5.3 Energy content (in watt-seconds). The energy content of a fully charged dc capacitor is determined by the following formula:

$$W = \frac{CE^2}{2}$$

Where:

W = energy content in watt-seconds.

C = nominal capacitance in farads.

E = dc voltage rating in volts.

6.5.4 AC component. The rating given is the steady-state dc voltage, or the sum of the dc voltage and the peak ac voltage, provided that the peak ac voltage does not exceed 20 percent of the rating at 60 Hz, 15 percent at 120 Hz, or 1 percent at 10,000 Hz. Where heavy transient or pulse currents are encountered, the requirements of this specification are not sufficient to guarantee satisfactory performance, and due allowance must therefore be made in the selection of a capacitor.

6.5.5 Barometric pressure (reduced) (see 4.7.8).

6.5.5.1 Ceramic- or glass-cased tubular capacitors. The dc voltage that may be applied to ceramic- or glass-cased tubular capacitors at altitudes from 50,000 to 100,000 feet may be obtained from figure 3.

6.5.5.2 Metal-cased tubular capacitors. The dc voltage that may be applied to metal-cased tubular capacitors at altitudes other than 80,000 feet may be obtained from figure 4, except that the dc voltage rating must not be exceeded.

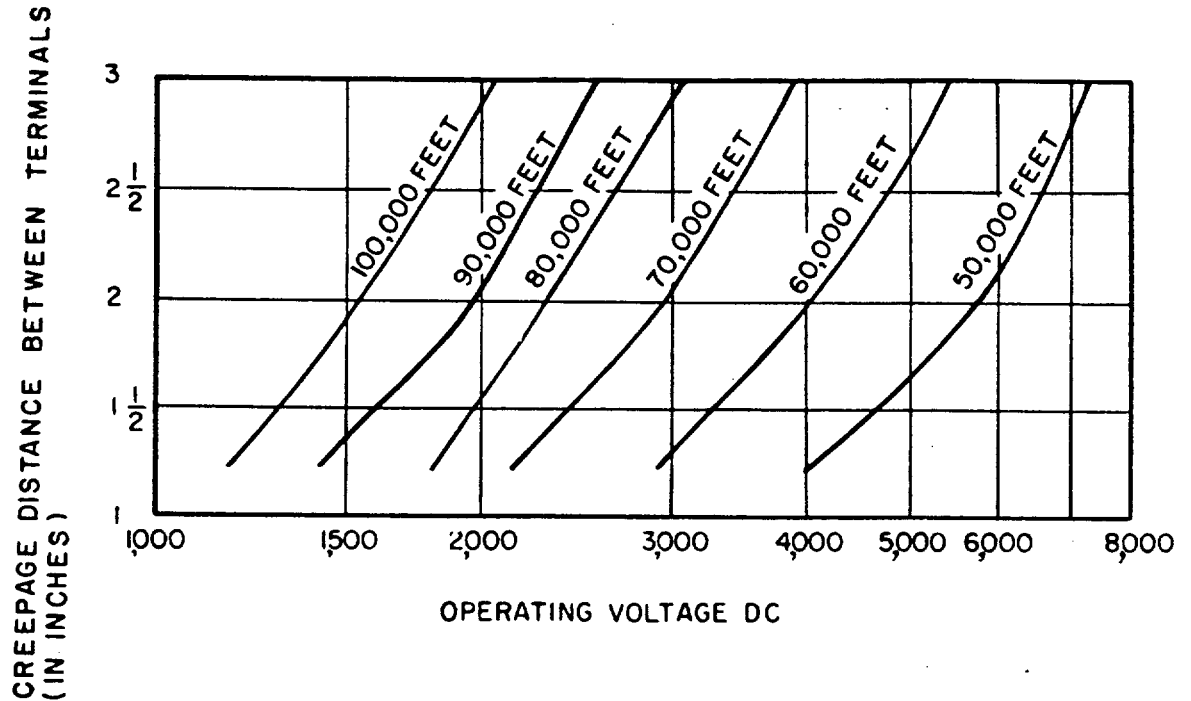


FIGURE 3. Permissible operating voltage at altitudes from 50,000 to 100,000 feet.

6.5.6 Representation of minimum insulation-resistance requirements. A graphical representation of minimum insulation-resistance requirements, as specified in the applicable specification sheet, is shown in figure 5.

6.5.7 Life at temperatures and voltages below and above rated. The failure rates used in this specification are referred to operation at rated voltage at the maximum rated temperature. The sampling plans and failure-rate determinations throughout the specification assume an acceleration factor of 5 for the life test conducted at the maximum rated temperature and 140 percent of rated voltage. Lower failure rates than those for which the manufacturer has obtained qualification may be achieved by operating the capacitors at lower voltage, or at lower temperatures, or both. Factors by which failure rates are to be multiplied under conditions other than maximum conditions are shown on figure 6 (characteristic K only).

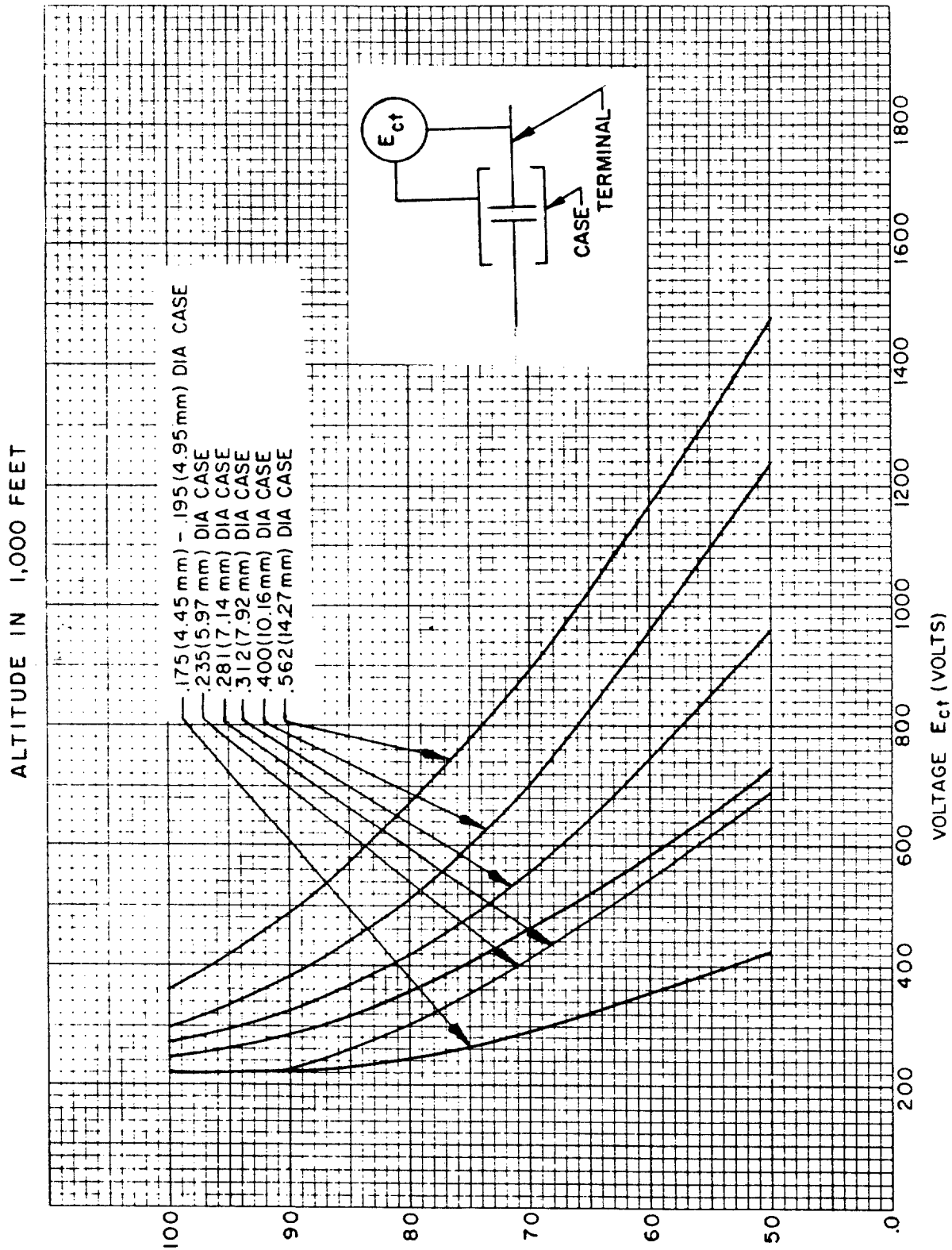


FIGURE 4. Permissible operating voltage at altitudes other than 80,000 feet.  
(Metal-cased tubular)

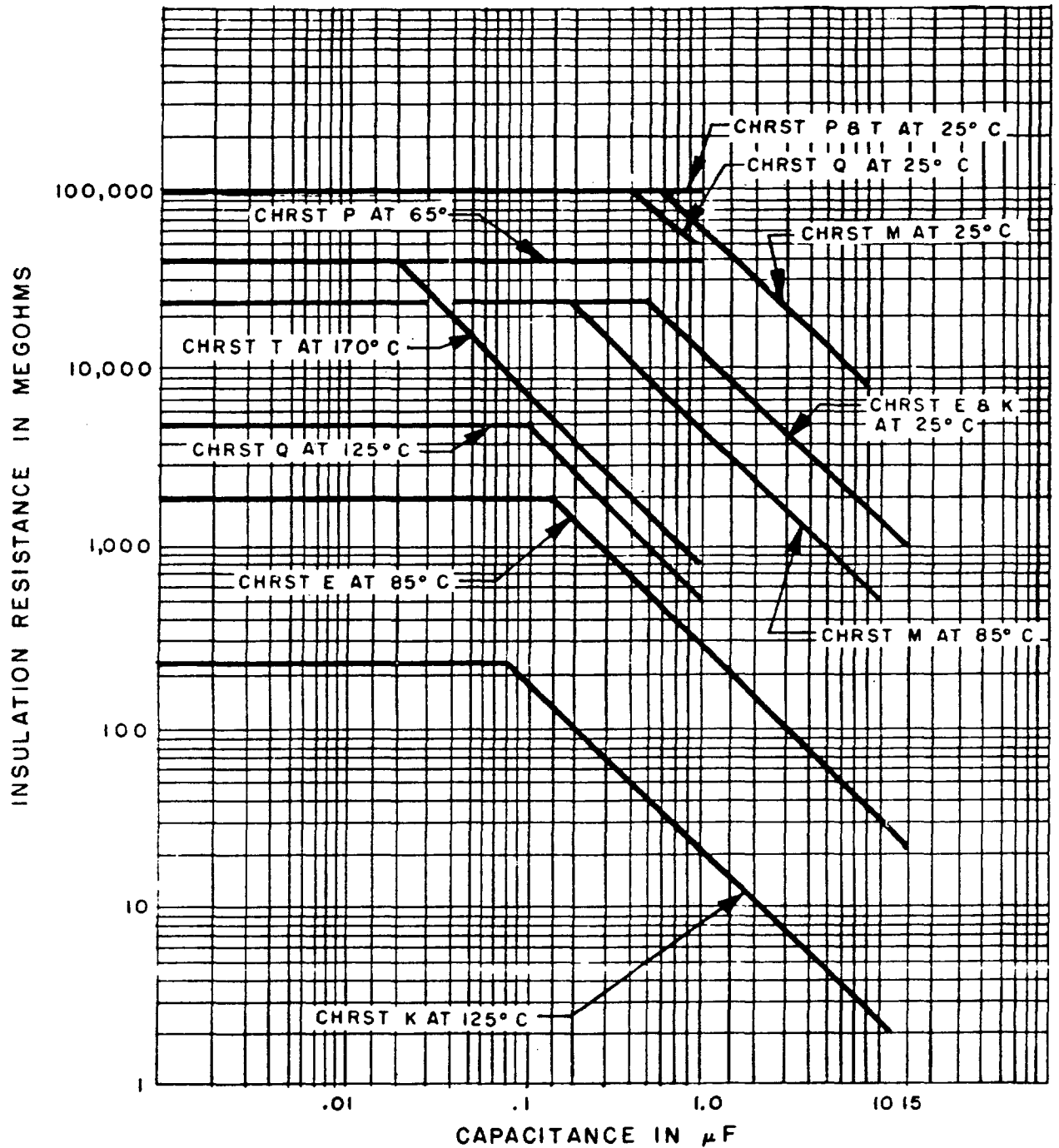
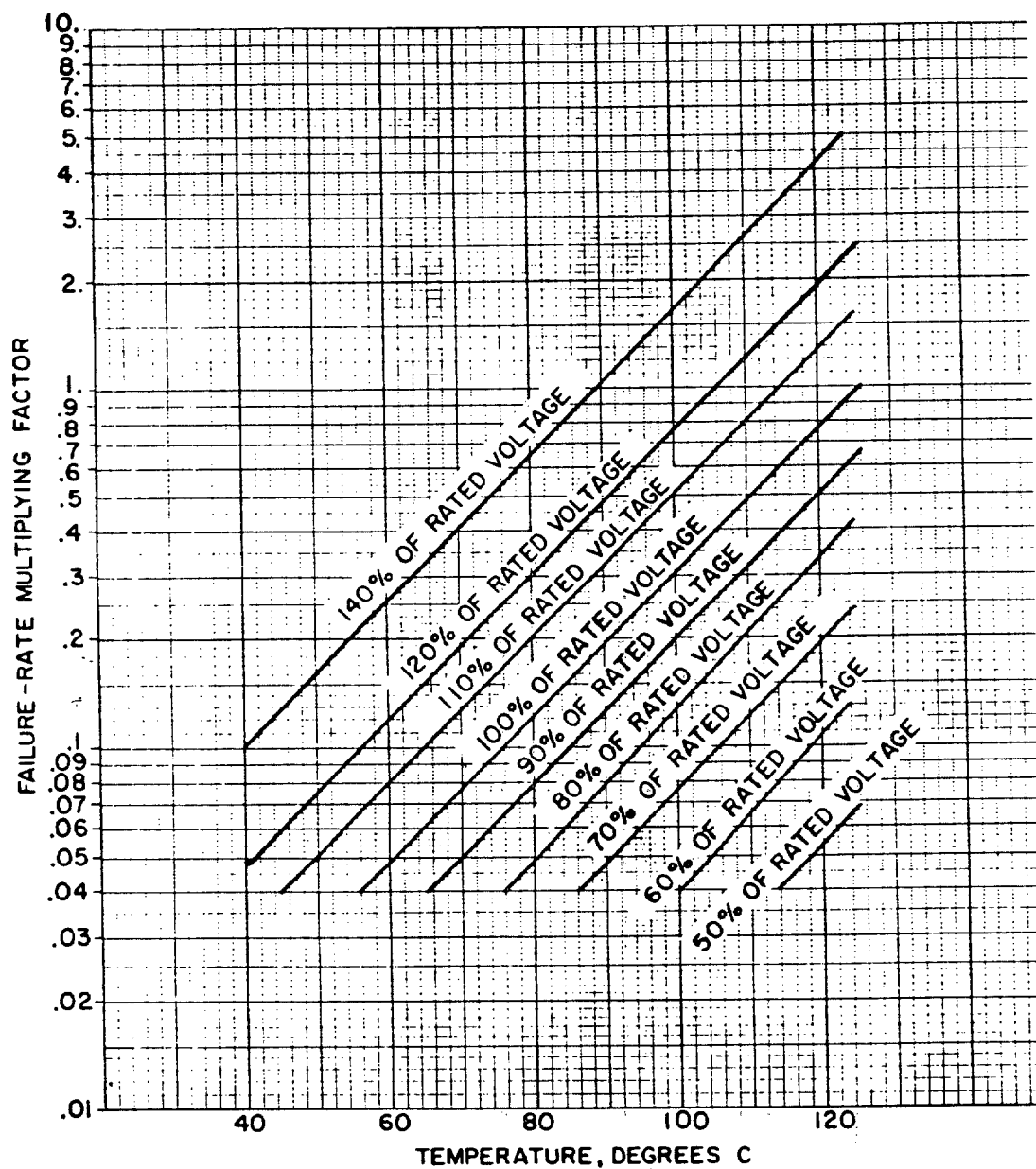


FIGURE 5. Graphical representation of minimum insulation - resistance requirements by dielectric as specified in the applicable specification sheet.



NOTE: Curves for 100 percent of rated voltage and higher are based on the 5th power rule and curves for 90 percent of rated voltage and below are based on the 4th power rule.

FIGURE 6. Life at temperature and voltages relative to percent rating.  
(Characteristic K only)

6.6 Selection and use information. Equipment designers should refer to MIL-STD-198, "Capacitors, selection and use of", for standard capacitor types and selected values chosen from this specification. MIL-STD-198 provides a selection of standard capacitors for new equipment design.

6.7 Interchangeability and substitutability. Whenever possible, items covered by this specification shall be used to replace items covered by MIL-C-14157, "Capacitors, fixed, paper (paper-plastic) or plastic dielectric, direct current (hermetically sealed in metal cases) established reliability, general specification for" and MIL-C-25, "Capacitors, fixed, paper-dielectric, direct current (hermetically sealed in metal cases) general specification for."

6.8 Changes from previous issue. Asterisks are not used in this revision to identify changes with respect to the previous issue, due to the extensiveness of the changes.

## APPENDIX

## PROCEDURE FOR QUALIFICATION INSPECTION

## 10. SCOPE

10.1 This appendix details the procedure for submission of samples, with related data, for qualification inspection of capacitors and retainers covered by this specification. The procedure for extending qualification of the required sample to other capacitors and retainers covered by this specification is also outlined herein.

## 20. SUBMISSION

20.1 Single-type capacitor submission. The following details apply:

- a. Sample size - As specified in table VIII.
- b. Sampling criteria - Sample units of the same style, terminal, circuit, characteristic, rated voltage, capacitance, capacitance tolerance, and vibration grade will be submitted.
- c. Extent of qualification:
  - (1) Circuit diagram 1 will qualify circuit diagram 3 in the same capacitor design.
  - (2) Qualification in one characteristic does not constitute qualification in any other characteristic.
  - (3) Any capacitance tolerance may represent all other authorized capacitance tolerances.
  - (4) Vibration grade 3 will qualify vibration grade 1 provided that the designs of the capacitors are the same.
  - (5) Qualification of insulated styles will be the basis for qualification of uninsulated styles of the same design.
  - (6) Styles CQ07, CQ09, CQ13, CQR09, CQR13, CQR19, CQR29, CQR33, CQR39, and CQR49 require individual voltage and characteristic qualification. Style CQ07 will qualify style CQ06, style CQ09 will qualify styles CQ08, and CQ12; CQR09 will qualify style CQR12; CQR29 will qualify CQR32, and CQR39 will qualify CQR42, provided the type submitted has the same impregnant or filling compound. The highest capacitance value submitted in each voltage rating will confer qualification of all units of the same style and lesser capacitance with the same voltage rating.
  - (7) Style CQ20 qualification is limited to the watt-second rating qualified and lesser values in the same voltage rating.
  - (8) Qualification of ER styles will qualify applicable non-ER styles of the same characteristic, voltage rating, and case size.
  - (9) Qualification of style CQ72 is restricted to those capacitance values and voltage ratings equal to and less than the ratings represented within the same watt-second group of the submission. Except type CQ72D1ES105K3 will qualify units in the same watt-second group (characteristic E) with 12,500 volt ratings provided that type CQ72D1ET105K3 qualification is complete; otherwise, type CQ72D1ET504K3 will qualify lesser watt-second ratings of 12,500 volt units in characteristic E. Type CQ72D1KT254K3 will qualify type CQ72D1KS504K3 rated at 25 watt-seconds. Terminal style E4 will represent E3.
  - (10) Qualification approval granted for one of the lower failure rate levels will include qualification approval for all of the higher failure rate levels as indicated in table XVI.



TABLE XVI. FR Qualification data.

Failure rate level	Will qualify failure rate level
S - - - - -	S, R, P, M, L
R - - - - -	R, P, M, L
P - - - - -	P, M, L
M - - - - -	M, L
L - - - - -	L

20.1.1 Single type retainer submission. The following details apply:

- Sample size - As specified in table IX.
- Sampling criteria - Sample units of the same retainer designator, design and case size will be submitted.
- Extent of qualification - Qualification will be limited to the part number submitted.

20.2 Combined type submission. Qualification of the types submitted will be a basis for qualification of the style represented, based on the same provisions stated in 20.1 with the following exceptions: Voltage ratings are grouped in table XVII for the styles shown; samples are divided equally between the two voltage ratings of each group. Voltage ratings not listed in the table are qualified separately. Styles are grouped as shown in table XVIII.

TABLE XVII. Voltage rating groups.

Styles CQ07, CQ09, CQ13, CQR09, CQR13, CQR19, CQR29, CQR33, CQR39, CQR43	Style CQ20
Voltage rating	Voltage rating
600 and 400	15000 and 12500
200 and 100	10000 and 7500
50 and 30	5000 and 3000
	2000 and 1000

NOTE: In view of the relatively few sample units of each type represented, a combined-type submission will be treated similarly to a single-type submission, and the failure of one type will disqualify the entire submission.

MIL-C-19978E  
APPENDIX

TABLE XVIII. Examples of combined-type submissions. 1/

Styles	Types to be submitted	Number of sample units to be submitted	DC voltage rating	Watt-second rating
CQ06 and CQ07	CQ07A1QA105J3	45	50	.00125
	CQ07A1QB105J3	23	100	.005
	CQ07A1QC684J3	23	200	.0136
	CQ07A1QE474J3	23	400	.0376
	CQ07A1QF224J3	23	600	.0432
CQ08, CQ09, CQ12, and CQ13	CQ09A1KC105J3	23	200	.0200
	CQ13A1KC105J3	23	200	.0200
	CQ09A1KE474J3	23	400	.0376
	CQ13A1KF474J3	23	600	.0846
	CQ09A1KG474J3	23	1,000	.235
	CQ13A1KG474J3	23	1,000	.235
	CQ09A1MZ106J3	23	30	.0045
	CQ13A1MA125J3	23	50	.0015
	CQ09A1MB685J3	23	100	.0340
	CQ13A1MC105J3	23	200	.0200
	CQ09A1ME105J3	23	400	.0800
	CQ13A1MF684J3	23	600	.1224
	CQ09A1MG224J3	23	1,000	.110
	CQ13A1MG224J3	23	1,000	.110
	CQ09A1PA105J3	23	50	.00125
	CQ13A1PA105J3	23	50	.00125
	CQ09A1PC474J3	23	200	.0094
	CQ13A1PC474J3	23	200	.0094
	CQ09A1PE154J3	23	400	.0120
	CQ13A1PF224J3	23	600	.0396
	CQ09A1TC104J3	23	200	.0020
	CQ13A1TC104J3	23	200	.0020
	CQ09A1TE334J3	23	400	.0264
	CQ13A1TF154J3	23	600	.0275
CQ20	CQ20A1KG105K1	23	1,000	.500
	CQ20C1KJ684K1	23	2,000	1.36
	CQ20A1KL334K1	23	3,000	1.485
	CQ20C1KN154K1	23	5,000	2.375
	CQ20-1KR683K1	23	7,500	1.862
	CQ20-1KS393K1	23	10,000	1.950
	CQ20-1KT223K1	23	12,500	1.714
	CQ20-1KU153K1	23	15,000	1.688
CQ72	CQ72B1EG105K3	23	1,000	.5
	CQ72E1KG105K3	23	1,000	.5
	CQ72E1EN104K3	23	5,000	1.25
	CQ72D1ES104K3	23	10,000	5.0
	CQ72D1KS104K3	23	10,000	5.0
	CQ72D1ES105K3	23	10,000	50.0
	CQ72D1KT254K3	23	12,500	19.531
	CQ72D1ET105K3	23	12,500	78.125

See footnote at end of table.

MIL-C-19978E  
APPENDIX

TABLE XVIII. Examples of combined-type submissions. 1/ - Continued

Styles	Types to be submitted	Number of sample units to be submitted	DC voltage rating	Watt-second rating
CQR07	CQR07A1QA105J3M	82	50	.00125
	CQR07A1QB105J3M	41	100	.005
	CQR07A1QC684J3M	41	200	.0136
	CQR07A1QE474J3M	41	400	.0376
	CQR07A1QF224J3M	41	600	.0432
CQR09, CQR12, and CQR13	CQR09A1KC105J3M	41	200	.020
	CQR13A1KC105J3M	41	200	.020
	CQR09A1KE474J3M	41	400	.0376
	CQR13A1KF474J3M	41	600	.0846
	CQR09A1KG474J3M	41	1,000	.235
	CQR13A1KG474J3M	41	1,000	.235
CQR19	CQR19A1KD105J3M	41	300	.045
	CQR19A1KE105J3M	41	400	.080
	CQR19A1KF474J3M	82	600	.0846
CQR29, CQR32, and CQR33	CQR29A1MZ106J3M	41	30	.0045
	CQR33A1MA125J3M	41	50	.0015
	CQR29A1MB685J3M	41	100	.0340
	CQR33A1MC105J3M	41	200	.0200
	CQR29A1ME105J3M	41	400	.0800
	CQR33A1MF684J3M	41	600	.1224
	CQR29A1MG224J3M	41	1,000	.1100
	CQR33A1MG224J3M	41	1,000	.1100
CQR39, CQR42, and CQR43	CQR39A1KB105K3M	41	100	.0050
	CQR43A1KC105K3M	41	200	.0200
	CQR39A1KE474K3M	41	400	.0376
	CQR43A1KF474K3M	41	600	.0846
	CQR39A1KG474K3M	41	1,000	.2350
	CQR43A1KG474K3M	41	1,000	.2350

1/ This table is set up as a guide; for other combinations, reference is made to the text.

20.2.1 Combined type retainer submission. The following details apply:

- Sample size - As specified in table XIX.
- Sampling criteria - Retainers submitted may be divided between the largest and smallest sizes in the footed and spaded design as shown in table XIX or in the designs in the largest and smallest case size required for complete CQ72 qualification.
- Extent of qualification - Either submission of (b) above will confer eligibility for complete qualification of CQ072 brackets.

MIL-C-19978E  
APPENDIX

TABLE XIX. Example of combined sample submission.

Types to be submitted	Number of retainers to be submitted
CQ072FA1	14
CQ072SA1	14
CQ072FJ11	14
CQ072SJ11	14

20.3 Impregnant of filling compound. A minimum of .25 pound of each impregnant or filling compound used in the sample units for which qualification is sought shall be submitted.

30. DATA REQUIREMENTS

30.1 Test data. When examinations and tests are to be performed at a Government laboratory, prior to submission, all sample units shall be subjected to all of the examinations and tests indicated as nondestructive in table VIII. Each submission shall be accompanied by the test data obtained from these examinations and tests. The performance of the destructive examinations and tests by the supplier on a duplicate set of sample units is encourage, although not required. All test data shall be submitted in duplicate.

30.2 Description of items. The supplier shall submit a detailed description of the materials and constructional features of the capacitors being submitted for inspection, including information as to whether they are liquid impregnated or liquid filled; the type and quantity of the impregnant or filling compound; the type, thickness, and number of layers of capacitor dielectric material and foil; the material, thickness, and applied finish of the case; and details on the end seal and terminal assembly.

30.3 Certification of materials. The supplier shall submit certification, in duplicate, that the materials used in his components are in accordance with the applicable specification requirements.

Custodians:

Army - ER  
Navy - EC  
Air Force - 85

Preparing activity:  
Air Force - 85

Agent:  
DLA - ES

Review activities:

Army - AR, MI  
Navy - AS  
Air Force - 11, 17, 99  
DLA - ES

(Project 5910-1547)

User activities:

Army - AT, AV, ME  
Navy - OS, MC, SH

# STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions - Reverse Side)

1. DOCUMENT NUMBER

2. DOCUMENT TITLE

3a. NAME OF SUBMITTING ORGANIZATION

4. TYPE OF ORGANIZATION (Mark one)

☐

VENDOR

☐

USER

☐

MANUFACTURER

☐

OTHER (Specify): \_\_\_\_\_

b. ADDRESS (Street, City, State, ZIP Code)

## 5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

## 6. REMARKS

7a. NAME OF SUBMITTER (Last, First, MI) - Optional

b. WORK TELEPHONE NUMBER (Include Area Code) - Optional

c. MAILING ADDRESS (Street, City, State, ZIP Code) - Optional

8. DATE OF SUBMISSION (YYMMDD)

Source: <https://assist.dla.mil> -- Downloaded: 2016-11-15T21:47Z  
Check the source to verify that this is the current version before use.

(TO DETACH THIS FORM, CUT ALONG THIS LINE.)

**INSTRUCTIONS:** In a continuing effort to make our standardization documents better, the DoD provides this form for use in submitting comments and suggestions for improvements. All users of military standardization documents are invited to provide suggestions. This form may be detached, folded along the lines indicated, taped along the loose edge (**DO NOT STAPLE**), and mailed. In block 5, be as specific as possible about particular problem areas such as wording which required interpretation, was too rigid, restrictive, loose, ambiguous, or was incompatible, and give proposed wording changes which would alleviate the problems. Enter in block 6 any remarks not related to a specific paragraph of the document. If block 7 is filled out, an acknowledgement will be mailed to you within 30 days to let you know that your comments were received and are being considered.

**NOTE:** This form may not be used to request copies of documents, nor to request waivers, deviations, or clarification of specification requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

(Fold along this line)

(Fold along this line)

DEPARTMENT OF THE AIR FORCE



NO POSTAGE  
NECESSARY  
IF MAILED  
IN THE  
UNITED STATES

OFFICIAL BUSINESS  
PENALTY FOR PRIVATE USE \$300

**BUSINESS REPLY MAIL**

FIRST CLASS PERMIT NO. 73236 WASHINGTON D. C.

POSTAGE WILL BE PAID BY THE DEPARTMENT OF THE AIR FORCE

AFALD/PTS  
Gentile AF Station Dayton, OH 45444

